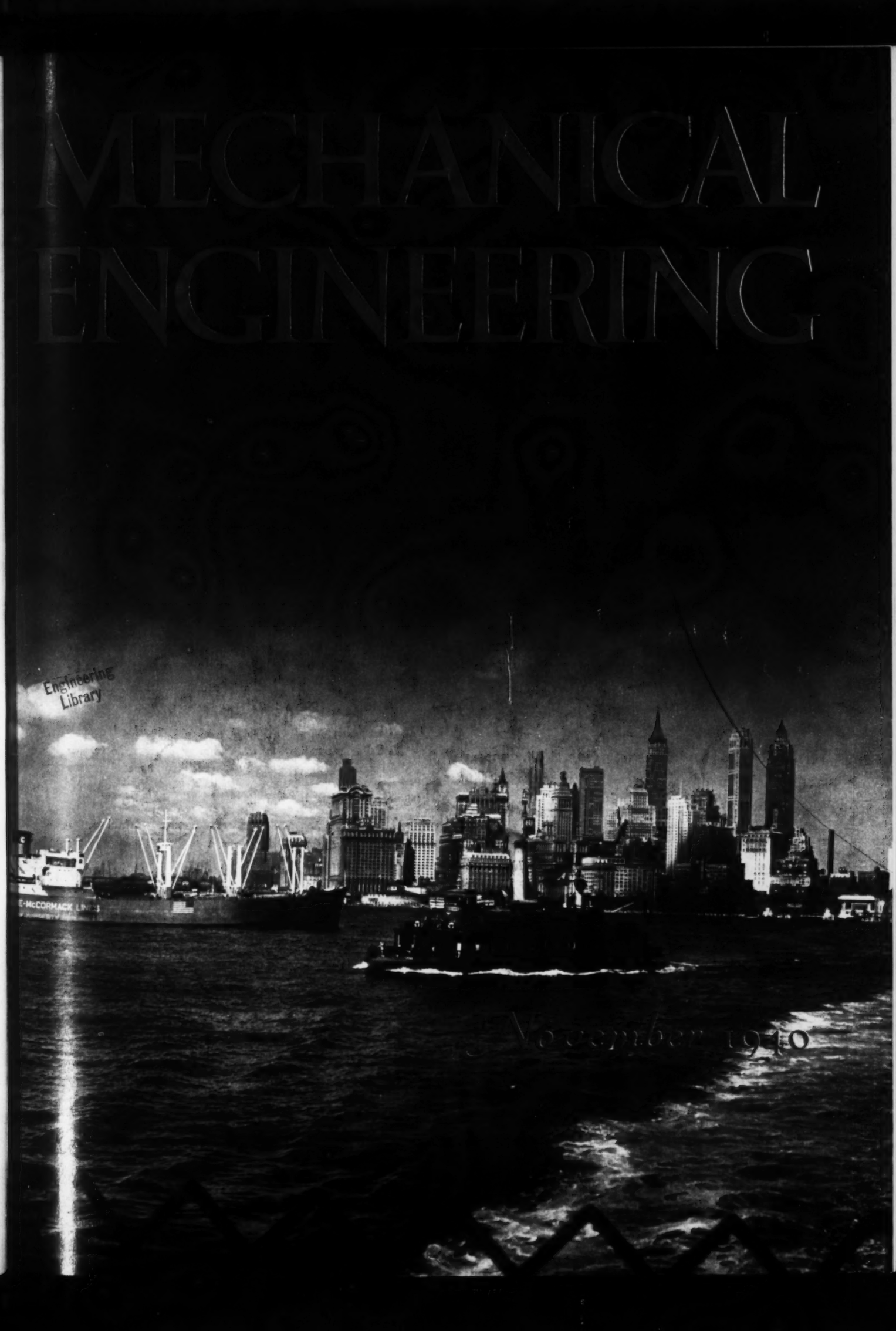
MECHANICAL ENGINEERING



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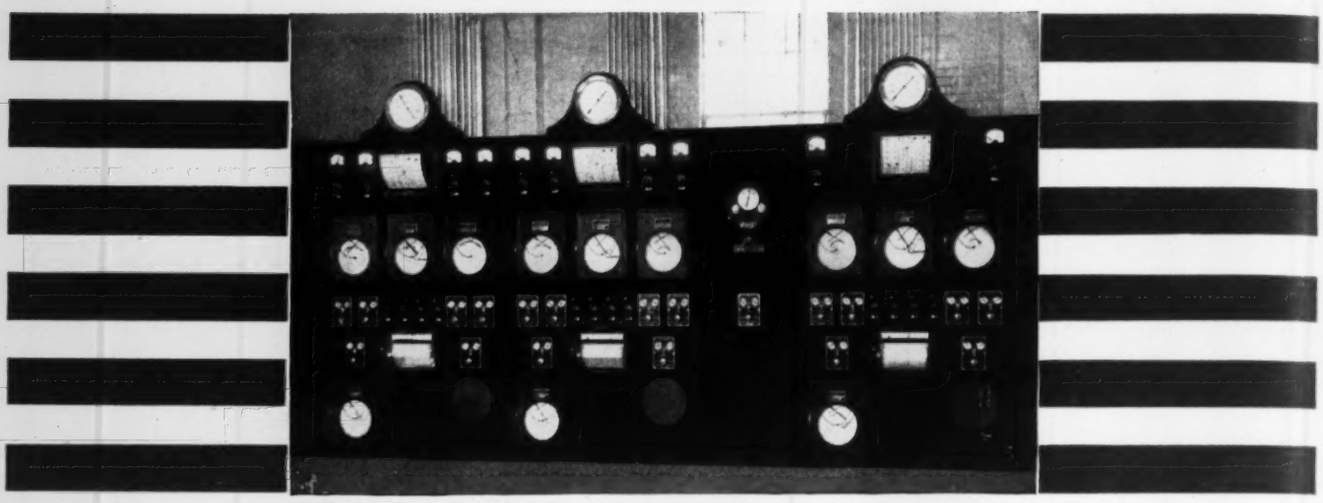

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MECHANICAL ENGINEERING

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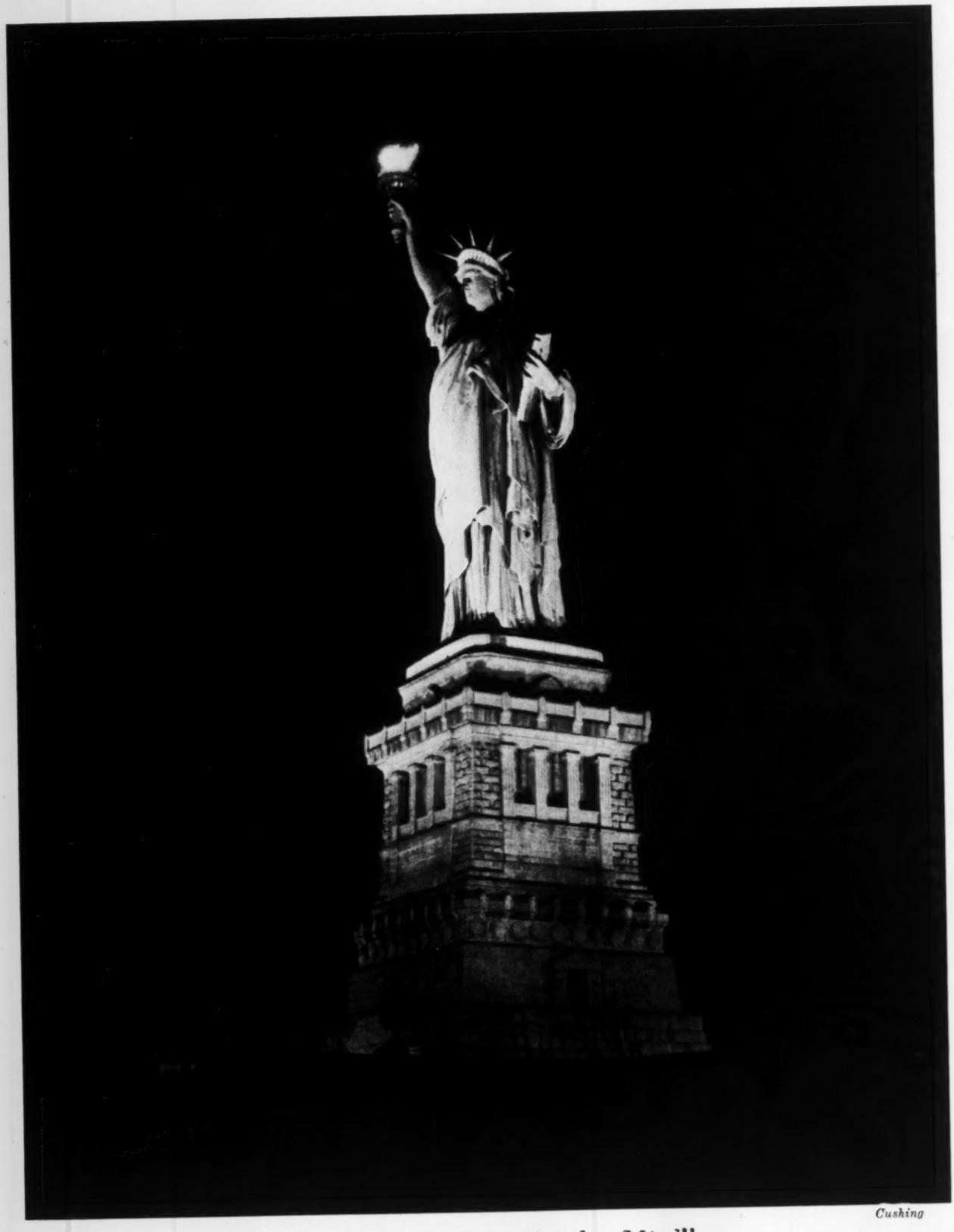

Cushing

"Eternal Spirit of the Chainless Mind"

VOLUME 62
No. 11

MECHANICAL ENGINEERING

NOVEMBER
1940

GEORGE A. STETSON, *Editor*

A.S.M.E. Carries On

NO ONE can predict what conditions we shall be facing early in December when The American Society of Mechanical Engineers holds its Annual Meeting at the Hotel Astor in New York. The national election will have been held. The country may actually be at war. In any event many members will be in the services and many more engaged in some portion of the defense program. Superimposed upon the nation and on most persons individually will be the burden of extraordinary concern in the world conflict. The needs of the present are likely to overbalance the needs of the future.

Such has been experience. In commenting on the slow delivery to or complete disappearance from the Library's shelves of some foreign engineering periodicals, Harrison W. Craver, director of the Engineering Societies Library, says in his annual report that engineers were so concerned with military production during the last war that they wrote little of permanent value in advancing the art of engineering. Shall we repeat this experience?

It is to be hoped that we shall not. Obviously, many engineers will be too busy with essential production to engage extensively in research. But we should strive not to permit this preoccupation to become too general. For our needs are pressing, not only to defend ourselves, which means development as well as production, but to preserve the advantages of industrial leadership among the nations that we normally enjoy.

Our job is threefold. First, we must prosecute with all the energy at our command the work of producing for the national defense. Second, we must maintain peacetime production at as near a normal level as possible. Third, we must continue development of new products and techniques necessary for success in wartime and peacetime. All of these jobs are fundamentally engineering.

Because it has been in the forefront of progress throughout its sixty years of existence, The American Society of Mechanical Engineers has a moral obligation not to slacken, but indeed to revitalize, its work in the development of its field. The 1940 Annual Meeting indicates that the Society is meeting that obligation. Whatever the reason for it may be, the fact is that pressure of papers to be presented forced the Committee on Meetings and Program to abandon its former policy of restricting to an arbitrary maximum the number of papers to be presented. As a result, the tax on members in attendance to find ways of visiting all of the simultaneous sessions that may appeal to their interests and the tax on publication finances become heavy. The list to choose from is long.

In such an extensive program as that arranged for the 1940 Annual Meeting, it is gratifying to note the large number of papers reporting researches and analyses of new fundamental problems. This places emphasis on the function of the Society in developing new fields for the future as well as aiding in improvements in today's production. The principle must be carried away from the meeting and spread into all national institutions. It is the function of the engineering college, for example, to pass on existing knowledge to young men through educational processes and experiences. It is no less their function to develop new knowledge through research. Not every man competent in one of these fields is competent in both. There is a danger, particularly in times like the present, to divert men who are particularly able to carry on development work into tasks that are routine production; to turn colleges into trade schools, research workers into operatives. In the long run—and change comes quickly when nations are at stake—we are forced to rely upon something new. Engineering societies must keep this fact before them.

Need for Skilled Labor

FROM the need the nation has for skilled mechanics may spring collateral advantages quite as important as an increase in the supply of such trained men. If we were to rediscover the essential dignity of labor that combines skill of hand with trained intelligence, we might re-establish the era that provided the foundations of our industrial supremacy by acknowledging the social value of productive work. We might convince our youth, and particularly their parents, that to learn a trade that in America's industrial youth produced men like William Sellers, Joseph R. Brown, James Hartness, and Warner and Swasey, to mention but a few, holds as much opportunity and serves society as usefully as a clerkship that is marked with the respectable halter of a white collar. Just as a people cannot become economically sufficient by taking in one another's washing, so also can they not become great by doing one another's paper work. Some fingers may be molded to grasp a pencil, but others have a traditional skill with more productive tools. The hand fashioned by nature to wield a hammer may serve its owner to ill purpose if it is employed casting up figures in a ledger. The fabulous twenties may have been the heyday of the bond salesman; today witnesses the triumph of the machinist. The world has lost its faith in scraps of paper and is being maintained by those who can fashion metals.

We need what mechanical and productive skill we can

muster to defend our way of life, to meet the demands of reconstruction, and to maintain our leadership in the industrial civilization whose conflict with older forms based on the imperialistic control of natural resources and avenues of trade must eventually cease.

We need also a finer quality of leadership in that group of men and women who labor with their hands. This leadership is not likely to be successfully improved from without by academicians and social theorists. Its emergence will only be delayed by a system which, through social prestige based on cheap education at the so-called college level, puts a premium on jobs that may be done with soft hands and a clean collar. Its coming will be hastened when there is less shortcutting of the road that lies through the shop to the office, for there is no understanding of men that can compare with that which comes with working beside them.

We need too—the list is long but let this suffice—more schools through which men may enter these productive trades. There will always be applicants for the degree-granting college. Our list of technical institutes is short. The graduates of these institutes frequently attain as conspicuous success and as solid satisfaction as do the graduates of colleges. These schools are not blind alleys for those whose genius is production, and production is one of the world's sorest needs.

Thus spake the Son of Sirach: "All these trust to their hands: and every one is wise in his work. Without these cannot a city be inhabited."

Freedom and Engineering

AS MEN remember who as schoolboys knew Byron as "required reading," or took to him naturally in the romantic enthusiasm of adolescence, the verse which follows the one quoted under this month's frontispiece is, "Brightest in dungeons, Liberty! thou art." Today these verses have new significance.

The age in which Byron lived was revolutionary. Poets and authors expressed what was uppermost in men's minds—Liberty. The western world was seething with the attainment of civil and political liberty. Freedom was in the air. The enslavement of superstition was being broken by the advancement of science. Crushing burdens of physical labor were being transferred to machines. Space-time restrictions that held all but hardy adventurers within a few miles of their homes and confined communication to press and post if travel were denied were rapidly being reduced by science and engineering. The restraints of social and religious bondage were being loosened. Even the limitations imposed on population by food supply were being slackened as men learned the technique of more efficient production. Men fought and died for liberty, and what men win by sacrifice they prize.

Today the world is reawakening to the ardors and enthusiasms of the late eighteenth and early nineteenth centuries. In some parts of it liberty is being preserved with sacrifice, in others it is, temporarily at least, lost. But in this country an unquestioning acceptance of liberty and the spirit of freedom in its widest sense has scarcely been challenged to the extent of demanding sacrifice as the price of its preservation. The challenge is being sounded; the necessity for sacrifice is imminent. The torch of Liberty burns brighter as the clouds that threaten to engulf it grow blacker.

When the perverted uses of emancipation from earth-bound traffic drove Britons into bombproof shelters they learned the literal significance of Byron's words, "brightest in dungeons," and day by day they come forth to go about their accustomed tasks with renewed strength and determination. Having freed the mind, the body, and the soul, they suddenly find their liberties threatened by the fruits that freedom won; the victims, rather than the beneficiaries, of the age of science and production that flourished in Freedom's air.

No one can believe that the spirit of freedom can suffer permanent eclipse and the human race still continue to progress. In the face of the greatest physical destruction Great Britain has ever known she has achieved the moral triumph of rediscovering through sacrifice the value of freedom and national unity. So it must be with the rest of the world, if anything better than the peace of slavery is to be obtained.

In a chapter in his autobiography "Pilgrim's Way," written during England's first year of war, Lord Tweedsmuir recalls how the Pax Romana was broken by the pressure of barbarian hordes from central Europe exerted against the hollow shell of a decadent Roman civilization. The Dark Ages followed. It was not, he said, the destruction of civilization that he feared for the world today but rather what he called a "de-civilization, which is civilization gone rotten," brought about by the decay that the modern world might suffer because of the misuse of science that should be its greatest strength. "Not for the first time in history," he says, "have the idols that humanity has shaped for its own ends become its master." But in the bomb shelters of England there is no evidence of de-civilization. Moral fiber, is not necessarily destroyed by civilization based on science.

Some years ago, it is said, a London paper published the headline, "Storm on the English Channel; Europe Isolated." One used to hear this quoted as evidence of a feeling of complacent superiority. But today it has a special significance, just as Byron's verse has new meaning, for there *is* a storm on the English Channel and Europe *is* isolated. But even in Europe there must be millions to whom Liberty is bright because of the darkness that surrounds it. Freedom and engineering progress go hand in hand; what stifles one stifles the other.

Memorial Biographies

BECAUSE the Memorial Biographies section of the A.S.M.E. Transactions is distributed only on request, it is appropriate to note its appearance in case the notice in our October issue escaped attention.

Here is inspiration for young men. Here live again the exploits of honored friends. Future generations shall read about them and be able to picture what manner of men carried on the work of the most productive era of engineering in America.

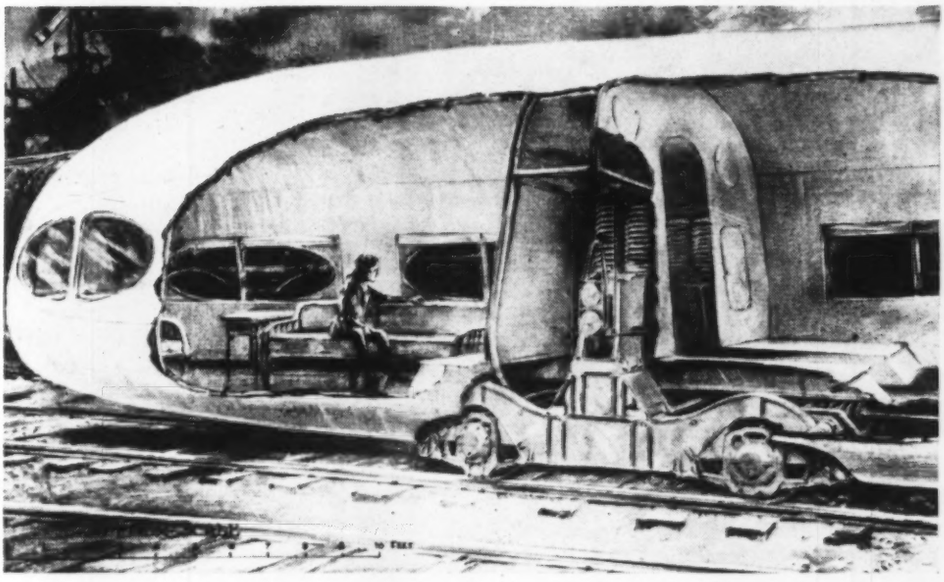

FIG. 1 SKETCH OF EXPERIMENTAL CAR AND SUSPENSION SYSTEM

A Fundamental Development in SUSPENSION *and* CONSTRUCTION *for* RAILROAD CARS

By P. K. BEEMER,[1] F. C. LINDVALL,[2] E. F. STONER,[1] AND W. E. VAN DORN[1]

HIGH speed in railroad-passenger-train operation is no novelty, nor is the achievement of passenger comfort with leisurely schedules. However, high speed with comfort presents problems which have thus far necessitated extensive improvement in rail and roadbed, involving expensive track realignment and surfacing. Such changes, merely to accommodate high-speed passenger equipment with some degree of comfort, surely are not economical, and therefore provoke the thought that a study of the riding problem, based on fundamental dynamics, might yield a truck-and-body-suspension system which would provide comfort at high speed on ordinary track.

The wheels of a railroad passenger truck, in rolling along a track, are constrained to follow all the vertical and lateral irregularities existent in the tracks. These irregularities may be minimized by careful and expensive maintenance of way, but never completely eliminated. Additional lateral wheel motion occurs as oscillation within the limits of flange clearance, induced by wheel-tracking errors and truck nosing. Inadequate curve compensation and improper rail alignment on curves also give rise to lateral forces which seriously affect the stability of the car body mounted on trucks in the conventional manner.

The support of the car body on the wheels must provide not only adequate isolation against these vertical and lateral wheel motions, but also stability under all ordinary operating conditions. As is well known, the car body may be isolated against vertical vibrations by using springs having a large static deflection. A 10-in. deflection is common and gives a resonant frequency of 1 cycle per sec. The transmissibility of such a system, the ratio of the body motion to the wheel motion, is low for all track irregularities which occur at high speed, and a high degree of comfort results.[3]

CONVENTIONAL TYPES OF SPRING SUSPENSION

However, in conventional railroad-truck construction, the springs are at a considerable distance below the center of gravity of the body, and instability in the form of objectionable and even dangerous body roll results from the use of "soft" springs.

Precisely this experience in the automotive industry followed the use of springs of greater and greater static deflection. Body roll, particularly on curves, became objectionable, and has been minimized by cross-stabilizers or "sway bars" designed to give the body freedom of vertical motion but restricted roll. This scheme has been incorporated in some recent railroad trucks in an effort to control the instability of soft truck springs. However, some of the benefit of soft springs is lost because on standard track with staggered rail

[1] Pacific Railway Equipment Company, Los Angeles, Calif.
[2] California Institute of Technology, Pasadena, Calif.

Contributed by Committee RR-5 of the Railroad Division for presentation at the Annual Meeting, New York, N. Y., December 2–6, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[3] "Vibration of Rail and Road Vehicles," by B. S. Cain, Pitman Publishing Corp., New York, N. Y., 1940.

joints, free truck roll is desirable and the stabilizers act to stiffen the springs for this type of action.

Lateral freedom of the suspension system is also desirable in order that the wheels may be free to follow the track irregularities without transmitting these motions to the car body. The swing hangers of the standard truck provide this freedom but, due to limitations of space, are rather inflexible in design.

ADVANTAGES OF ABOVE-GRAVITY SUSPENSION

In view of the limitations of the conventional railroad truck, the object of the development forming the basis for this paper has been to produce a car-body suspension system which would provide the requisite isolation against vibration and maintain stability. The goal has been comfort at high speed on ordinary track with safety and economy of weight. The fundamental scheme has been to support the car above its center of gravity in a manner which is inherently stable. Ideally, the above-gravity suspension hangs the car above its center of gravity on an imaginary longitudinal axis which is allowed all necessary vertical and lateral movement against soft-spring restraints. The wheels follow the rail irregularities while the body floats about a central position.

The above-gravity suspension has a further outstanding advantage over the conventional truck. In taking curves above superelevation speeds, the outward force acting on the center of gravity causes the body of a conventional car to roll outward on the truck springs, adding to the discomfort of passengers. However, with the car supported above its center of gravity, the outward curve force rolls the body in the direction for comfort, pendulum-wise, adding effectively to the superelevation of the track in so far as comfort and stability within the car are concerned.

A practical realization of the benefits of the above-gravity suspension has been the purpose of the design and experimental work leading to the cars described in this paper. The original designs and the subsequent modifications adhere to a basic ideal car mounting in which the car is elastically supported at each end on a virtual, universal center bearing on the longitudinal center line above the center of gravity of the car body. This virtual support permits sufficient universal swivel action of the truck relative to the car body to account for all operating conditions, and the springs together with the positioning linkage cooperate to achieve the desired vibration isolation. The actual car support, however, is at two points on either side of the car center line with a third attachment between the truck and the car body below the floor level. Consequently, no objectionable interference with normal use of the car interior is introduced by the suspension. The desired motions are provided by flexure of the support system, suitably positioned and restrained. In the early models, mechanical linkage and pivoted support arms provided the universal swivel action. In the present form, all motions between the truck and car body occur solely through elastic flexure, leading to an extremely simple lightweight truck and suspension system, Fig. 1.

The practicability of the above-gravity suspension system has been convincingly demonstrated in trial runs of a two-car experimental unit,[4] Fig. 2.

BASIC PRINCIPLES OF SUSPENSION SYSTEM

The rear truck of this unit illustrates the basic principles involved in the suspension system and is shown in Figs. 1 and 3. The car body rests on soft coil springs which are recessed into the car structure on either side of the center aisle. These springs carry only vertical load and allow, within limits of safe stress, sufficient horizontal movement of the top relative to the bottom for all lateral and turning movements of the truck in normal service. A basic analysis of the mechanics of helical springs disclosed two facts which made the application feasible with properly designed springs; i.e., the stresses, due to these lateral deflections, are not severe, and the springs can be deflected laterally and yet be stable. Lateral movement of the car body floating on the main springs is restrained by control arms and links which act on the body above the center of gravity. The control arms mounted in rubber give a variable spring rate for lateral motion, so that the car floats about a center position with small restraint, equivalent to the action of very long swing hangers, and is brought to a yielding stop for large lateral swings. The longitudinal position of the truck is maintained by the thrust tube or "wagon tongue" which is anchored in rubber at one end to the truck frame and at the other to the car underframe. The rubber mountings of the longitudinal tie permit lateral movement of the truck and angularity on curves as well as constituting barriers against noise transmission. The coil-spring suspension involves no sliding or rotating parts carrying the weight of the car. The elements which have been described replace the center plate, side bearings, bolster, chafing plates, bolster springs, spring plank, and swing hangers used in all standard passenger-car trucks.

The car bodies of the test unit were, for reasons of simplicity, fabricated of plywood into stressed-skin or semimonocoque structures. High strength and rigidity were thus obtained at minimum weight. Moreover, most of the usual auxiliary equipment of passenger cars was omitted from these units so that the two-car articulated unit 145 ft in length weighed only 33 tons on the rail. The unit which was photographed during the course of a test run is shown in Fig. 2.

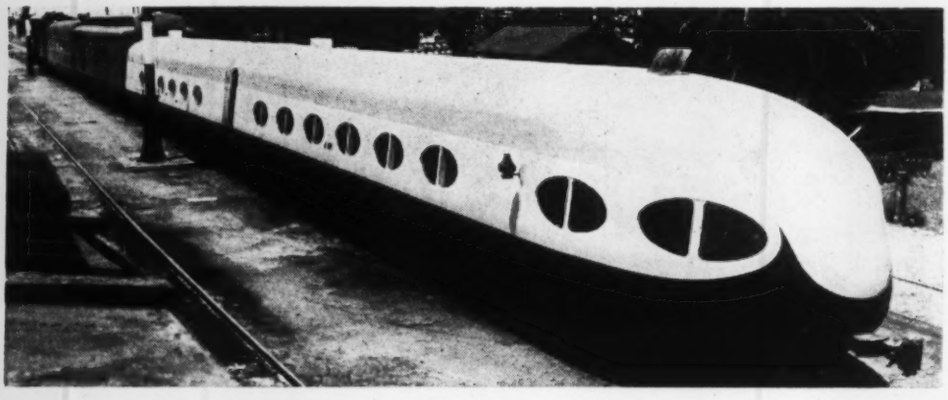

FIG. 2 TWO-CAR EXPERIMENTAL TRAIN UNIT; LOW FLOOR LEVEL

ROAD-TEST PROGRAM

An extensive road-test program, during which various changes were made, showed that the only modifications desirable were reduction of shock-absorber control and application of softer rubber disks in the lateral-control arms to provide a lower lateral frequency.

During test runs, readings were taken by means of scratch

[4] "New Pendulum-Type Cars Tested," *Railway Age*, vol. 104, no. 7, 1938, pp. 294–295.

gages to determine deflections of all rubber parts and springs. From previously obtained load-deflection curves of each of these units, maximum loads were determined for all principal elements of the truck. Some of the runs were made at high speeds on a very rough secondary freight road, and a few of the scratch-gage recordings showed lateral loads at the journal equal to the vertical load on the journal. It was feared by some railroad engineers that the coil-spring truck with no center plate or side bearings might be subject to "nosing," that is, wandering continuously from one side of the track to the other as permitted by the necessary flange clearance and lateral rail flexure. However, no tendency to nose has ever been observed on either the single trucks or the articulated truck of the experimental cars. Both conical and cylindrical treads were tried to see if this action would occur.

The high location of some of the truck parts and access doors in the body made it possible to make changes during runs. Shock absorbers have been revalved, connected, and disconnected, and the lateral control has been adjusted while the train was traveling at 90 mph. Due to the close access, no danger was involved in such work.

Cathode-ray-oscilloscope observations were made of the high-frequency vibrations throughout the truck suspension system at a variety of speeds. A very high value is now placed on the use of rubber in some parts of the truck, as a result of these studies.

To record lateral shocks transmitted to the car body, a very simple and crude accelerometer was used. Small hardwood blocks, "tumble blocks," were carefully calibrated for tip-over value on an inclined plane and were matched in two sets of three blocks each. During most of the test runs, one set of these blocks was operated in either of the two experimental cars and the other was operated in one of the standard cars in the test train. The surfaces on which the blocks were mounted were carefully leveled for each setup. The test cars consistently showed fewer "tumbles" than did any of several standard-type cars used on various test runs. A typical record is given in Table 1.

TABLE 1 NUMBER OF FALLS RECORDED ON A RUN OF 85 MILES AT AN AVERAGE SPEED OF 61 MPH

Lateral acceleration (per cent of gravity).....	9	12.6	19
Test car A-22	170	20	0
Modern standard car.....	582	54	4

The degree of accuracy of the tumble-block records is indicated by a close correlation with data taken from an entirely different source. Deflections of the lateral-control arms of several different magnitudes were recorded for a known mileage. Since the rate of this unit was known, these deflections were converted to forces, and thus force expressed as a percentage of the body weight was plotted against number of occurrences per mile. This curve, Fig. 4, agreed closely with the results of the tumble blocks.

Despite their extreme light weight, these cars in road tests, at speeds up to 100 mph, demonstrated outstandingly better riding qualities than older, heavyweight equipment and modern, lightweight coaches utilizing conventional trucks. The demonstrations have verified conclusively the prediction of theory, that heavy equipment is not necessary for good riding. Static deflection of the spring system, whatever the car weight may be, determines the transmissibility of the system, and ultimately the comfort of the passengers within.

THREE RAILROADS PURCHASE EXPERIMENTAL COACHES

Based upon the success of the experimental train unit, a more elaborate program was undertaken with railroad co-

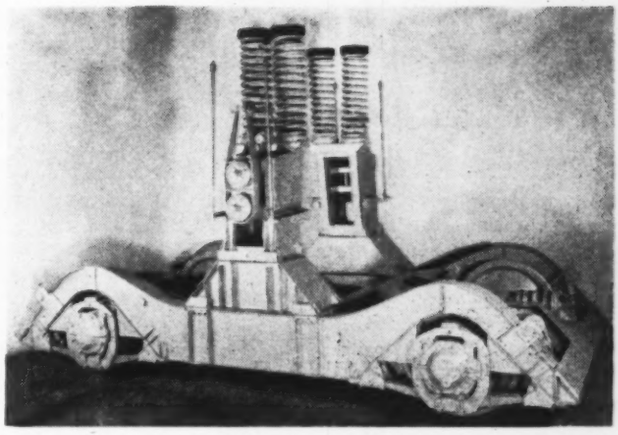

FIG. 3 TRUCK FOR EXPERIMENTAL CAR

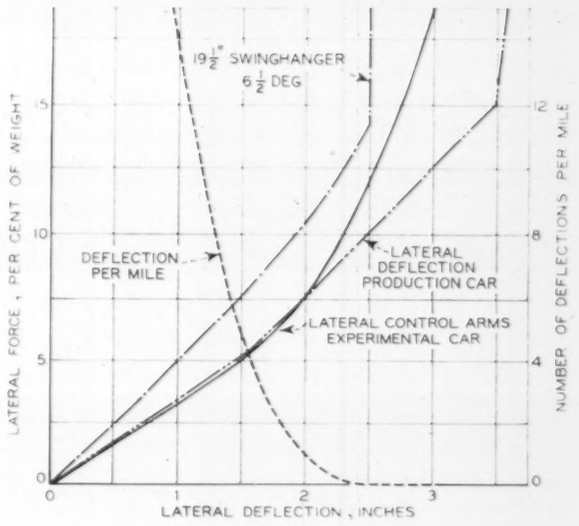

FIG. 4 LOAD-DEFLECTION CURVE; LATERAL CONTROL

operation. The Santa Fe, the Great Northern, and the Burlington roads each contracted for a de luxe type coach incorporating the above-gravity suspension system and skin-stressed lightweight body structure. The specifications require that the cars be built for unrestricted interchange service, although it is understood that one car with the new suspension system when coupled in with standard equipment is subject to end reactions which alter the performance of the spring system. Consequently, the three railroads have agreed for a test period to keep the three cars together in road service in order that the middle car of the group can function in a representative manner.

Naturally, the weight of the service car will be much greater than that of the experimental car, and the floor heights will be different. Dynamically, however, the two types of car will be similar. The relationship between the point of lateral restraint and the height of the body center of gravity will be the same in the new car as in the experimental unit. Similarly, the spring deflections and lateral spring rate found satisfactory in the test car are being used in the new coaches. These and other design data are given in the detailed description of trucks and body structure.

EXPERIMENTAL TRUCK PERFORMANCE SATISFACTORY

The successful performances of the experimental trucks indicate that the journal springs for service trucks should also be relatively stiff. If a truck is to be sufficiently stable against

rolling due to unbalanced side forces, the journal springs, being very low, cannot be sufficiently soft to permit a fundamentally low frequency for the truck frame; therefore, for each truck frame, natural frequency is to be high and is to be safely above the highest imposed vibration encountered in service. The $1^3/_4$-in. static deflection chosen for coil-type journal springs gives the following natural frequencies of the truck frame vibrating as a unit: Vertical, 6 cycles per sec; lateral, 7 cycles per sec; pitching, 14 cycles per sec. At a speed of 120 mph, a wheel encounters 33-ft rail joints at an interval of 5.34 every second. Since even the fastest schedules do not permit operation at this speed, there is little likelihood of truck-frame vibration being troublesome.

The coil springs mounted just above the journal box are so applied that some lateral movement can take place between the journal box and the truck frame. This lateral movement is permitted by rubber and steel vulcanized pads on the side of the pedestals which are deflected in compression to relieve lateral shocks. The arrangement of parts is different from that used on the experimental cars, but the characteristics are the same.

Truck frames are arc-welded of high-tensile low-alloy steel and are stress-relieved before machining.

The greater weight of the production cars necessitated the use of eight body springs per truck. These springs are mounted just above the frame side members and extend upward within the body to the body-support structure. The static deflection of 10 in. together with the rubber insulator at the top of the spring with a deflection of $^3/_8$ in. provide highly satisfactory isolation of the body from disturbances in the truck. As was done for the experimental car springs, considerable analytical and test work was performed to establish correct relationships between static deflection, working height, and pitch diameter to obtain freedom of lateral movement and stability. In these springs, the greatest lateral movement encountered in normal service increases the working stress near the ends of the coil by 25 per cent.

Fig. 4 shows the load-deflection curve for the lateral springs used in production cars. These springs are two plates clamped rigidly to the side of the truck frame extending between the body-support bulkheads to a point above the center of gravity of the body. Lateral tie rods with rubber-mounted end connections attach the lateral spring to the car body at a point about 20 in. above the center of gravity of the entire body assembly.

Hydraulic shock absorbers, mounted on the side of the truck frame, connect by means of long vertical tie rods to the body structure. These two vertical tie rods are also used to prevent the truck from being separated from the car body by derailments or overturning. Hydraulic shock absorbers, mounted in the body-support structure, connect by means of a lateral link to the top of the lateral spring housing.

The truck thrust tube, used to position the truck longitudinally with respect to the body, connects to the truck through a large rubber fitting at the center of the transom. The body connection of the thrust tube is provided through a similar fitting attaching to a bracket mounted directly under the draft-gear pocket. This thrust tube also was designed to meet requirements of the Association of American Railroads for crash conditions.

The wheels, axles, and bearings to be used on the production cars are made to the standards of the respective railroads for light modern equipment. Wheels are rolled steel, 36 in. diam, triple wear. Journal bearings are for $5^1/_2$-in. journals and are of the tapered-roller type.

A summary of the general requirements of a railroad-car-body structure must recognize the fact that strength and rigidity are of primary importance. Other requirements are light weight, good appearance, smooth exterior for low side-wind resistance, and last, but not least, low cost.

REQUIREMENTS FOR RAILROAD-CAR BODY

Keeping in mind these requirements, a study of the various types of structure, which are at all suitable, substantiates the conviction that a "stressed-skin" structure is the proper choice. After years of experimenting with truss structures of all types, the use of stressed-skin has become almost universal in aircraft. As expressed by Carl F. Greene,[5] of the Army Air Corps: "One of the most useful and far-reaching contributions to everyday engineering construction is now being made or stimulated by certain modern developments in the structures of aircraft. This consists substantially in the transition from internal structural frameworks to external structural shells."

The railroads, too, have long recognized the fact that, since a railroad car must have an outside "skin" or sheathing, it may as well work structurally. The girder-type car is not new, and neither is the use of the roof as a part of the load-carrying structure. In addition, modern buses and large-sized truck and trailer bodies are being designed to utilize the outside sheathing as a load-carrying member.

The fundamental logic of a stressed-skin structure is, therefore, substantiated by its actual use in all types of transportation vehicles. Of these, however, only aircraft has so far taken full advantage of all the benefits to be gained from the use of stressed-skin construction. It is the intention of the company with which the authors are associated to extend these benefits to the field of railroad vehicles. The experimental train unit, incorporating the above-gravity suspension system, to which reference has been made,[4] utilized the stressed-skin structure.

Good appearance and reduced air resistance are inherent in a stressed-skin car. Flat box-like sides, required with truss construction, are unnecessary, and large-radius curves may be used for the contours to give a smooth, pleasing effect. The use of a smooth external sheathing, well supported by stiffening members to prevent buckles, results in a structure having a minimum of air resistance, especially for quartering winds.

The term "stressed skin" is a good one for the structure being considered, because it is functionally descriptive. As used in this paper, the term stressed skin infers not only that the skin, or outside sheathing, is expected to act as a load-carrying member of the structure, but also that it is suitably reinforced so that it truly is effective as a load-carrying element.

[5] "Stressed-Skin Construction," by C. F. Greene, MECHANICAL ENGINEERING, vol. 58, 1936, pp. 279–282.

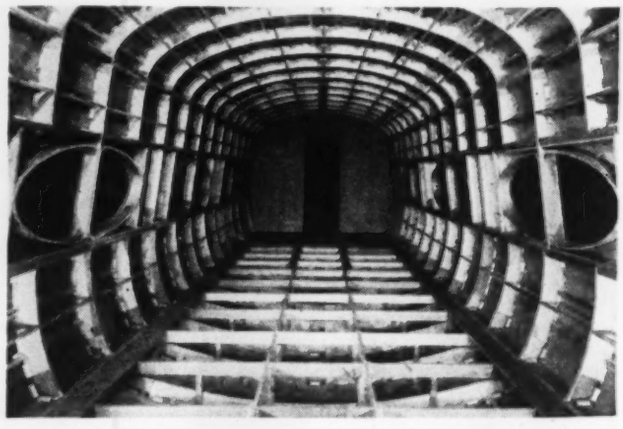

FIG. 5 REINFORCING RINGS AND LONGITUDINAL STIFFENERS AS APPLIED TO PLYWOOD SKIN OF EXPERIMENTAL CARS

Fig. 5 shows the basic reinforcing rings and longitudinal skin stiffeners as applied in the wooden structure of the experimental train unit. Fig. 6 is a view of the steel car roof, and shows clearly the closely spaced stiffeners and carlines which provide the adequate sheathing reinforcement of the true stressed-skin structure. Moreover, the illustration emphasizes the essential simplicity of this type of structure.

RELATIVE STRENGTH OF CONVENTIONAL AND STRESSED-SKIN STRUCTURES

Because of the more efficient use of material made possible by stressed-skin design, relatively thin material can be used. Problems of elastic stability are thus introduced. For example, a flat sheet, loaded in compression, will fail by buckling at a relatively low stress. If the flat sheet is reinforced with stiffeners disposed in the direction of the load, the strength of the sheet-stiffener combination is appreciably higher, not only because of the additional area of the stiffeners, but because the allowable stress is greatly increased. As an example, consider a flat panel as found in the side of a modern girder-type railroad car, between two side posts and the belt rail and side sill. The panel size is $25\frac{1}{2} \times 34$ in., Fig. 7(*a*). The thickness is $\frac{3}{32}$ in. and the material will be assumed as high-tensile low-alloy steel with a modulus of elasticity of 29×10^6 psi, and a yield strength of 50,000 psi. The edges will be assumed as simply supported, a conservative assumption since the adjacent sheet and the framing members to which the sheet is attached will give some restraint. The formula

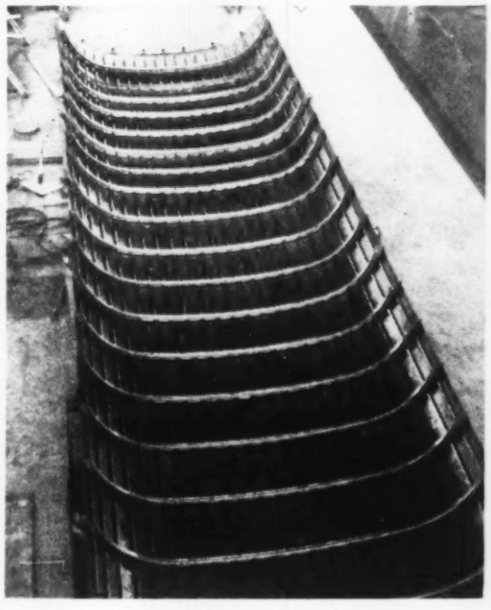

FIG. 6 STEEL-ROOF-PANEL ASSEMBLY

for the critical compressive stress, obtained from Timoshenko[6] is

$$\sigma_{cr} = KE\frac{h^2}{b^2}$$

where K = constant influenced by proportions of panel = 3.94
E = modulus of elasticity = 29×10^6 psi
h = thickness of panel = 0.09375 in.
b = width of panel normal to load = 34 in.

$$\sigma_{cr} = 3.94 \times 29 \times 10^6 \times \frac{0.09375^2}{34^2} = 870 \text{ psi}$$

Loaded area = $34 \times 0.09375 = 3.18$ sq in.
$P = 3.18 \times 870 = 2760$ lb

The panel weighs 23.2 lb, and has a strength-weight ratio of 119.

Contrast this with a panel of equal size and less weight, Fig. 7(*b*), made up of a somewhat thinner sheet, 0.06 in. thick,

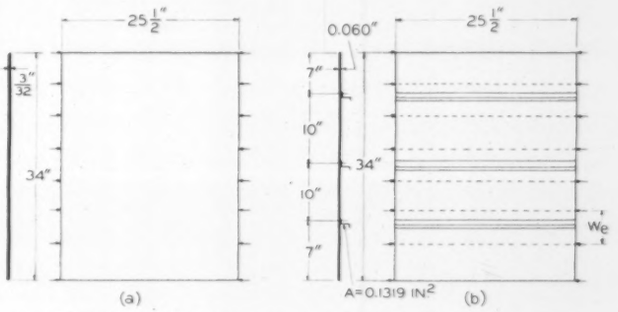

FIG. 7 (*a*) FLAT COMPRESSION PANEL WITHOUT STIFFENERS
(*b*) FLAT COMPRESSION PANEL WITH STIFFENERS

reinforced with stiffeners in the direction of the load. The stiffeners may be designed as columns so that their allowable stress approaches the yield strength of the material. The stiffeners chosen are formed zees having an allowable column stress of 40,000 psi and an area of 0.1319 sq in. each. The stiffeners stabilize the sheet to which they are attached so that, in the immediate vicinity of the stiffener, the allowable stress in the sheet is the same as that in the stiffener. The allowable stress in the sheet decreases, however, with distance from the stiffener being at a minimum midway between two stiffeners. For purposes of calculation, the assumption is made that a narrow strip on either side of the stiffener will have an allowable stress equal to that of the stiffener, and the remaining sheet, midway between stiffeners, is assumed to carry no load. The width of the loaded strip, called the "effective width," is such that the total allowable sheet load equals the actual compressive strength of the supported sheet under the true-stress distribution. Timoshenko's[6] formula for effective width is

$$w_e = 1.7h\sqrt{\frac{E}{\sigma_s}}$$

where w_e = effective width, in.
h = sheet thickness = 0.06 in.
E = modulus of elasticity = 29×10^6 psi
σ_s = stiffener allowable stress = 40,000 psi

For the 0.06 sheet, the effective width is

$$w_e = 1.7 \times 0.06 \times \sqrt{\left(\frac{29 \times 10^6}{40{,}000}\right)} = 2.75 \text{ in.}$$

The total effective area of the panel is the area of the stiffeners plus the area of the effective widths, or

$$A_t = 3 \times 2.75 \times 0.06 + 3 \times 0.1319 = 0.891 \text{ sq in.}$$

The total strength of the panel is then

$$P = 0.891 \times 40{,}000 = 35{,}600 \text{ lb}$$

The panel weighs 17.7 lb and has a strength-weight ratio of 2010.

Compare this with the strength-weight ratio of 119 for the unstiffened panel, and the advantage of true stressed-skin design becomes apparent. This is but one specific example of the

[6] "Theory of Elastic Stability," by S. Timoshenko, McGraw-Hill Book Company, Inc., New York, N. Y., 1936.
"Strength of Aircraft Elements," Army-Navy Aircraft Design publication.

increased structural efficiency which may be gained by a stressed-skin design.

In addition to the strength-weight advantages of a stressed-skin railroad car body, as illustrated by the previous example, there are other advantages of importance in the cars being built. The flooring is shear-connected into the structure, making the car body a huge tube, closed at both ends, with a high degree of torsional rigidity. The bending rigidity of the structure is likewise high since all the effective material is disposed as far from the neutral axis as possible. Consequently, under normal operating loads, the maximum stresses in the structure are low. Elliptical windows are used to reduce stress concentrations and to increase the shear rigidity of the body.

The use of closely spaced longitudinal stiffeners around the entire periphery of the structure, to reduce buckling and increase the total effective width of the sheathing, results in increased collision protection of the passengers, both for end and side loads. The side collision strength is further improved not only by the close spacing of side posts and carlines, but also by the fact that the floor beams, side posts, and carlines are aligned and spliced together to form a series of continuous frames, or rings, throughout the length of the car.

End-collision strength is improved by the large number of longitudinal stiffeners around the entire periphery, as well as by the fact that the corrugated flooring is arranged to have its corrugations parallel to the longitudinal axis of the car. The flooring also has a rigid shear connection to the center sill, so that loads applied to the center sill are distributed to the flooring and, thence, to the rest of the car structure.

WELDING THE CAR BODY

Truck load reactions are taken into the body by a pair of rigid transverse bulkheads near either end of the car. These bulkheads distribute the truck loads uniformly into the skin, and provide extra strength against lateral collision or overturn loads.

The entire body structure, excluding certain arc-welded end framing and draft-gear attachments, is fabricated with controlled spot welding. The special welding machine on which the roof panel of Fig. 6 was assembled is shown in Fig. 8. It consists essentially of a fixture to hold the work and a special series-welding head with two air-operated electrodes. Two fixtures have been provided, one for the roof panel and one for the side panels. Each is shaped to the outside contour of its respective panel and lined with copper sheet to serve as a back-up for the series welding. The smooth back-up results in spot welds, the external appearance of which is almost perfectly smooth.

The double-electrode welding head is mounted on a pair of trucks which provide both longitudinal and transverse movement of the electrodes over the work. The transverse truck is mounted on tracks curved so that the electrodes follow the contour of the panel, as seen in Fig. 8. The entire combination of welding head and trucks is mounted on a gantry which permits extensive movement of the machine along the work. A high-capacity transformer is mounted on the truck carrying the electrode cylinders, and moves with them, permitting a minimum cable length. An electronic timer controls the welding sequence and provides consistent spot welds having high strength.

The limitations of the paper have made it necessary to touch but briefly on many of the characteristics of stressed-skin construction. Similarly, the discussion of truck details has been restricted to permit a more general discussion of the broad principles and objectives involved and the mechanism used to achieve them. Taken together, the car structure and the suspension system represent an integrated design for a safe, comfortable railroad car for high-speed service. Because the resulting picture is new, it may appear complex. However, a careful study of the essential structure and mechanism, as compared in detail with the present conventional equipment, will reveal not added complexity but substantial simplification which is in turn reflected in cost and weight economy.

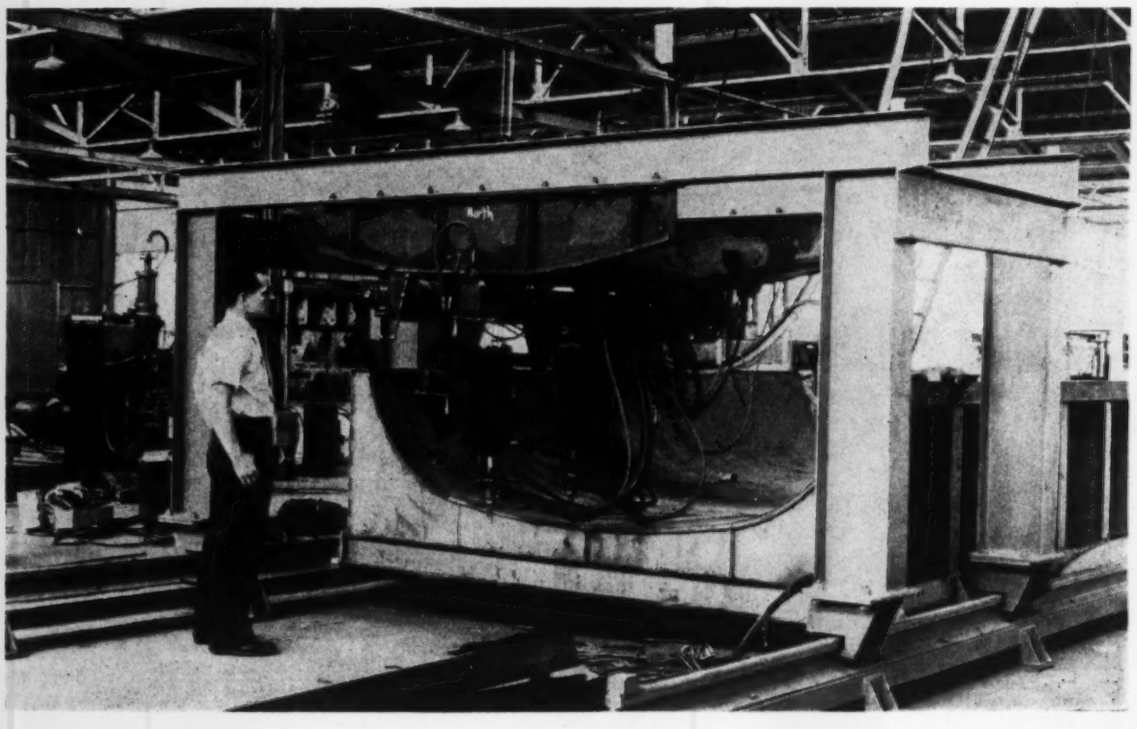

FIG. 8 SPOT-WELDING MACHINE FOR ROOF AND SIDE PANELS

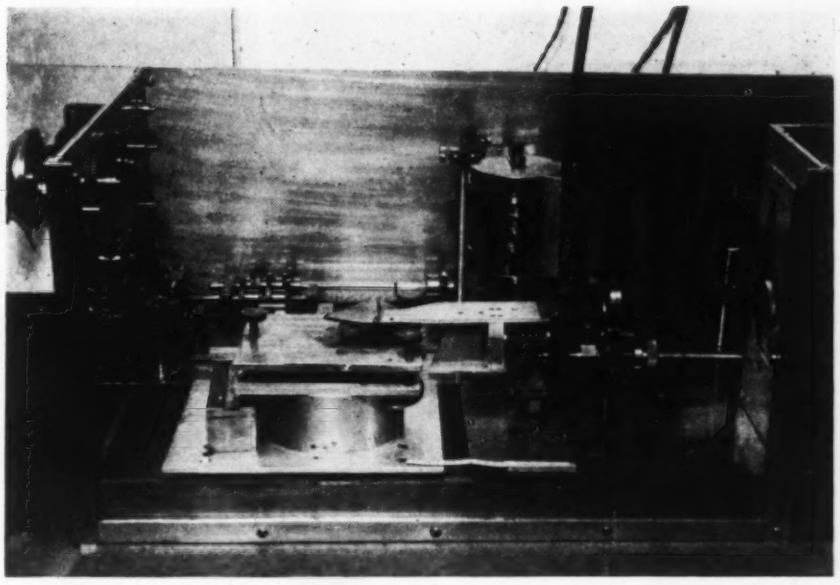

FIG. 1 THE PROFILOGRAPH

SURFACE QUALITY *of an* S.A.E. 3140 STEEL

A Study Based on Various Combinations of Speeds, Structures, and Cutting Fluids

By O. W. BOSTON and W. W. GILBERT

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THE machinability of a metal is rated in various ways, depending upon the particular item of greatest concern. Tool life, power consumption, and surface finish are of greatest importance and yet they are not interrelated. The acceptability of a product is often determined by the quality of the surface finish. Several of the factors which influence surface finish reported upon in this paper are cutting speed, cutting fluids, and the heat-treatment of the material cut.

Preliminary surface-finish tests previously reported were made when turning a cylindrical bar of S.A.E. 1045 steel.[1] It was found that the cutting speed had a marked influence upon the surface finish. Because of this effect, facing cuts were taken on the face of a disk, the cut starting at the edge of a $^1/_2$-in-diam hole, with a radial feed toward the outside at constant rotational speed. In this way, the cutting speed was increased constantly from a low speed near the center of the disk to a maximum speed at the outside diameter. Thus, the complete range of speeds was obtained in one cut.

Since finishing cuts are usually small, a light depth of cut of 0.0035 in. was used. In order to observe the surface more readily, a heavy feed of $^1/_{16}$ in. per revolution was used to make it possible to photograph the surface and measure the imperfections.

Some of the tests were made at very high speeds, and it was questioned if the high cutting speed at the outside diameter would dull the cutting tool and produce a change in surface finish due to this dullness. To check this variation, the normal testing procedure was reversed and the facing cut was started on the outside diameter and the tool fed toward the center of the disk. If the high speed did dull the tool, then the surface finish for low speeds would be changed. Several tests were made and it was observed that the surface finish was not changed by starting at the outside rather than at the inside and facing outward.

Again, to check the effect of dulling, tests were made on a cylindrical bar of S.A.E. 1045 steel.[1] First high and then low speeds were used alternately, and no variation due to tool wear could be detected unless the speeds were increased to a point high enough to damage the tool as determined by visual observation.

A 12-speed geared-head engine lathe was used, having 14-in. swing and 32-in. centers, driven by a constant-speed 3-hp motor

[1] "An Analysis of Machinability Data From Cold-Finished and Heat-Treated S.A.E. 1045 Steel," by O. W. Boston and W. W. Gilbert, Trans. American Society for Metals, vol. 28, March, 1940, pp. 186–208.

Contributed by the Special Research Committee on Cutting of Metals for presentation at the Annual Meeting, New York, N. Y., December 2–6, 1940, of The American Society of Mechanical Engineers.

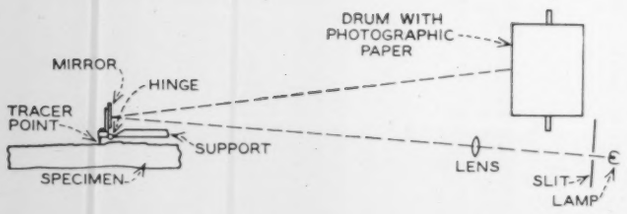

FIG. 2 DIAGRAM SHOWING OPERATING PRINCIPLE OF PROFILOGRAPH

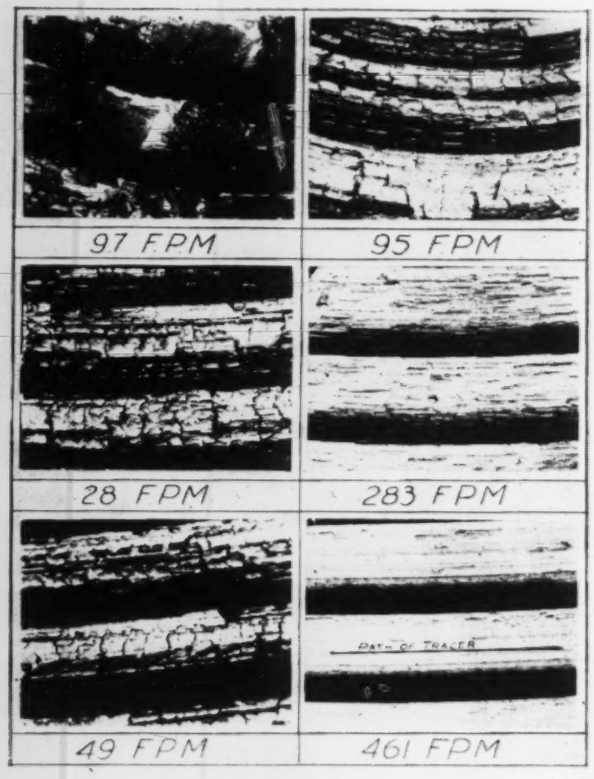

FIG. 3 EFFECT OF CUTTING SPEED
(S.A.E. 3140 steel; normalized and annealed, dry; ×13.6.)

through multiple-V belts. The cutting tool used in these tests was a $^1/_2$-in-square shank, tipped with tungsten tantalum carbide (Firthite grade R). This tool was ground to have working angles of 6 deg back rake, 6 deg side rake, 6 deg relief, 6 deg side relief, 6 deg end-cutting-edge angle, 0 deg side-cutting-edge angle, and $^1/_{16}$ in. nose radius (6-6-6-6-6-0-1/16).

The S.A.E. 3140 steel cut was the same as that used in a previous report[2] on tool-life cutting-speed relationship, when using cutting fluids. This steel had the following chemical analysis:

	Per cent
Carbon	0.42
Manganese	0.69
Sulphur	0.021
Phosphorus	0.017
Silicon	0.17
Nickel	1.41
Chromium	0.61

It was received in a normalized-and-annealed condition in the form of a forging 14 in. diam by 48 in. long, having an average Brinell hardness of 190.

During the tool-life tests, the log was reduced to a diameter of 5 in. For the surface-finish tests, a number of disks each $^1/_2$ in. thick were cut from the end of this log. The heat-treatment of these disks is given subsequently in this paper. These disks were faced at a wide range of speeds, with various cutting fluids, and for different structures, as outlined later.

Four cutting fluids used in these tests were applied at the rate of 1 gpm from a $^1/_2$-in-diam nozzle, directed vertically downward on top of the tool.

After surface-finish tests had been run on the lathe, the disks were photographed using a magnification of ×40. The disks then were measured for surface roughness using the profilograph shown in Fig. 1. A diagrammatic sketch of the fundamental principles of the profilograph is shown in Fig. 2. This machine makes it possible to obtain an enlarged profile of the surface by traversing the surface in a straight line in the bottom of the cut with an exceptionally sharp-pointed diamond. Movements of the diamond tracer cause a mirror to reflect a light beam, the path of which is recorded highly magnified on a photographic film. In all tests the vertical magnifications were ×1000, and the horizontal magnifications were ×32.

THE EFFECT OF CUTTING SPEED

In order to determine the effect of cutting speed, the S.A.E. 3140 steel in the normalized and annealed condition was cut dry, at speeds ranging from 9.7 to 461 fpm. Photographs of the surface at radii to give six different speeds ranging from 9.7 to 461 fpm are reproduced at ×13.6 in Fig. 3. These originally were taken at ×40. The path of the diamond tracer is shown in the bottom of the cut for the highest speed of 461 fpm in the lower right corner. The lower half of the dark path represents the crest or feed marks. Visual observation gives a rather clear indication that the machined surface, produced at the lower speeds, is much rougher than that obtained at the higher speeds. The best finish is obtained at the highest speed. The finish, as

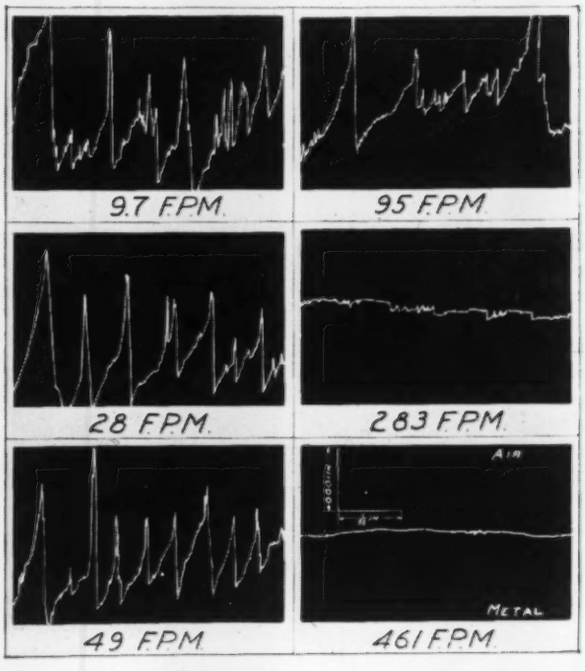

FIG. 4 PROFILOGRAMS FOR SURFACES IN FIG. 3
(Feed 0.0625 in. per revolution; depth 0.0035 in.; vertical ×1000; horizontal ×32.)

[2] "The Influence of Cutting Fluids on Tool Life in Turning Steel," by O. W. Boston, W. W. Gilbert, and C. E. Kraus, Trans. A.S.M.E., vol. 58, July, 1936, paper RP-58-11, pp. 371–378.

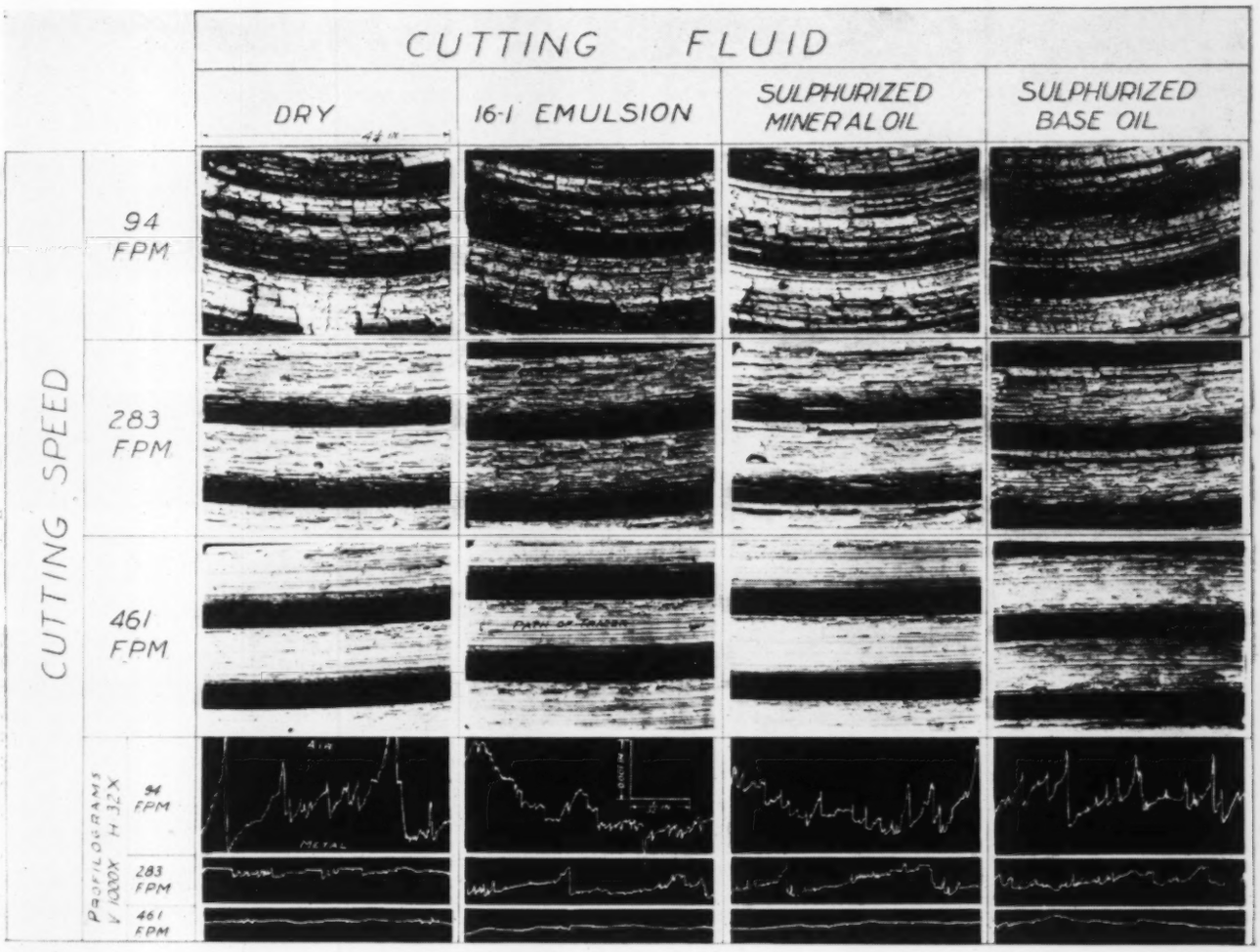

FIG. 5 SURFACE FINISHES AND PROFILOGRAMS FOR S.A.E. 3140 STEEL
(Normalized and annealed; dry facing cuts, using feed 0.0625 in. per revolution, depth 0.0035 in.; ×11.5.)

shown for the speed of 461 fpm, appeared to remain the same even for higher peripheral cutting speeds. Profilograms of the path of the beam, as it was deflected by the motion of the diamond point while being drawn over the cut surface in the bottom of the cut, are shown in Fig. 4 for the six surfaces shown in Fig. 3.

While the three surfaces at the lower speeds of 9.7, 28, and 49 fpm appear to be much different in the illustrations, the profilogram shows that there is not a great deal of difference in irregularity. There appears to be a definite improvement when a speed of 95 fpm is reached. However, if the speed is increased further, the surface quality is improved markedly. From the profilogram, as well as from visual observation, the surface at 283 fpm is very much better than the same surface for all lower speeds. The vertical steps caused by torn metal are very small and of the order of 0.0002 in., as compared with the scale in the lower right-hand corner of Fig. 4. The profilogram for the highest speed of 461 fpm is practically a continuous straight line which is maintained for all higher speeds.

It appears from this study, as well as others of a similar nature that, at the lower speeds, the chip is removed from the main body of metal by means of a large built-up edge. The cutting edge of the tool actually clears the machined surface and gives vertical irregularities on the torn surface, as shown by the profilogram, of from 0.002 to 0.0025 in. As the speed is increased, the built-up edge becomes smaller and recedes from the cutting edge so that the cutting edge itself actually produces the machined surface. The speed at which this occurs seems to be the optimum speed and should be obtained whenever good surface quality is desired. It is for this reason that cemented-carbide tools, or other tools which permit high cutting speeds, give a similar smooth machined surface.

INFLUENCE OF CUTTING FLUIDS

With definite indications that the maximum influence of cutting speed when cutting dry occurred for the speeds from 90 to 461 fpm, as shown in Fig. 4, this range of speeds was selected for a study of cutting fluids and their influence on surface quality. The cutting fluids used in this study are:

1 Dry cutting.

2 An emulsion of 1 part soluble oil to 16 parts distilled water.

3 A sulphurized-mineral oil containing 3.3 per cent sulphur and having a viscosity of 110 Saybolt sec at 100 F. (This oil is listed as No. 10 in previous reports.[2])

4 A sulphurized-base oil made by mixing 1 part sulphurized-lard oil containing 12 per cent sulphur with 8 parts plain mineral oil, having a viscosity of 110 Saybolt sec at 100 F. (This oil is listed as No. 11 in previous reports.[2])

While taking a facing cut as described, the various cutting fluids were applied at the rate of 1 gpm. Reproductions of photographs of the resulting surfaces at each of the three speeds are shown in the upper part of Fig. 5. Comparing the various illustrations at each constant speed indicates but little difference in the surface quality, except that the two sulphurized oils seem to produce a slightly better surface quality than the emulsion or dry cutting at 94 fpm. These differences are demonstrated to better advantage by referring to the profilograms for 94 fpm, as shown at the bottom of Fig. 5. The photographic reproductions, as well as the profilograms, appear to show little difference in surface quality at the cutting speed of 283 fpm for the various cutting fluids. It actually appears that the surface produced when cutting dry is best. At the highest cutting speed of 461 fpm, the surface quality when cutting dry, with the 1-16 emulsion, and with the sulphurized-mineral oil appears to be better than that produced with the sulphurized-base oil, both from the photographic reproductions and the profilograms. It is apparent, however, that, when cutting dry, as well as when cutting with the emulsion and the sulphurized oils, an increase in speed makes a great improvement in the quality of the machined surface.

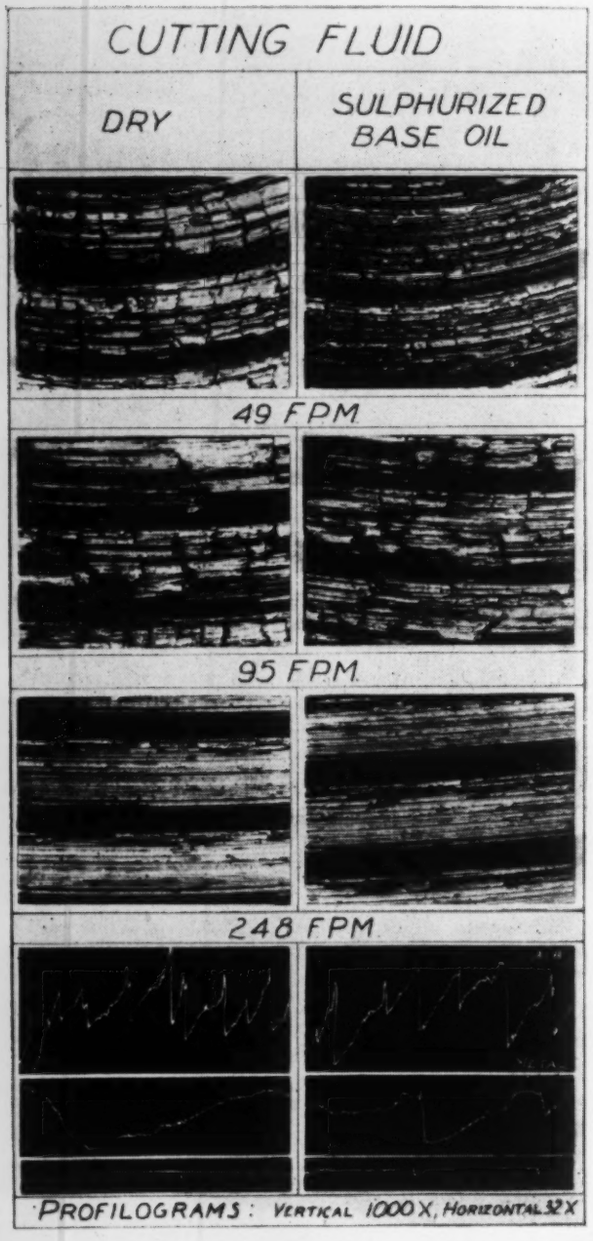

FIG. 6 SURFACE FINISHES AND PROFILOGRAMS FOR S.A.E. 3140 STEEL (Normalized; cut dry, using feed 0.0625 in. per revolution, depth 0.0035 in.; ×13.6.)

The influence of cutting fluids as outlined was shown on disks normalized and annealed. Two additional disks were reheat-treated by giving only a normalizing treatment. One of these disks was faced when cutting dry, and the second when the sulphurized-base oil was applied. Photographs of the resulting surfaces are reproduced in the upper part of Fig. 6, with the profilograms for the corresponding surfaces shown at the bottom of the illustration.

The surfaces produced at 49 fpm on the normalized disk from Fig. 6 appear to be about equal to the surfaces produced at 94 fpm on the normalized-and-annealed disks of Fig. 5. Further, the surfaces produced on the normalized disk at 95 fpm in Fig. 6 do not seem to be so good as those at the corresponding speed in Fig. 5. The profilogram shows that the character of the finish of the normalized disk at 95 fpm is quite different from that produced at the lower speed of 49 fpm. The latter consists of numerous deep depressions, whereas, the former consists of depressions of approximately the same depth, which occur less frequently. The profilogram for the normalized structure in Fig. 6 at 95 fpm is definitely superior to the corresponding surface of the normalized-and-annealed structure cut at 94 fpm in Fig. 5. In the same manner, a high-quality surface is obtained on the normalized structure at a low speed of 248 fpm, whereas, the surface for the normalized-and-annealed structure at 283 fpm definitely has not yet reached the best quality. The profilograms of the normalized structure at 248 fpm appear to be similar to those of the normalized-and-annealed structure at 461 fpm.

In conclusion, it is seen that the best surface quality for the normalized steel occurs at an optimum speed considerably lower than that for the normalized-and-annealed disk. The surface quality at the lowest speed is slightly better for the sulphurized-base oil than for dry cutting. There appears to be little difference, however, at the highest speed, unless perhaps it is in favor of dry cutting.

INFLUENCE OF HEAT-TREATMENT

Four disks were given the following heat-treatments:

1 As received, normalized, and annealed; Bhn 202.

2 Heated to 1500 F for 1 hr and quenched in oil. Drawn at 600 F for 2 hr; Bhn 460.

3 Heated to 1500 F for 1 hr and quenched in oil. Drawn at 1200 F for 2 hr; Bhn 255.

4 Normalized by heating to 1600 F for 1 hr and air cooling; Bhn 277.

Each disk was given a facing cut, the results of which are shown in Fig. 7. These illustrations indicate that the optimum speed for producing the best surface quality, at which time the cutting edge of the tool actually does the cutting, occurs at lower speeds for the structures of higher hardness. For example, the surface quality on the disk quenched at 1500 F and drawn at 600 F, having a Brinell hardness of 460, is poor at 28 fpm, but appears to have the optimum speed at 95 fpm. The steel quenched at 1500 F and drawn at 1200 F, having a Brinell hardness of 255, appears to have the optimum speed at 280 fpm. This compares favorably with that speed for the normalized disk, having a Brinell hardness of 277, although it appears that the optimum speed for the normalized disk should be slightly higher. However, the optimum speed for the normalized-and-annealed bar, having a Brinell hardness of 202, shown at the right in Fig. 7, is approximately 461 fpm.

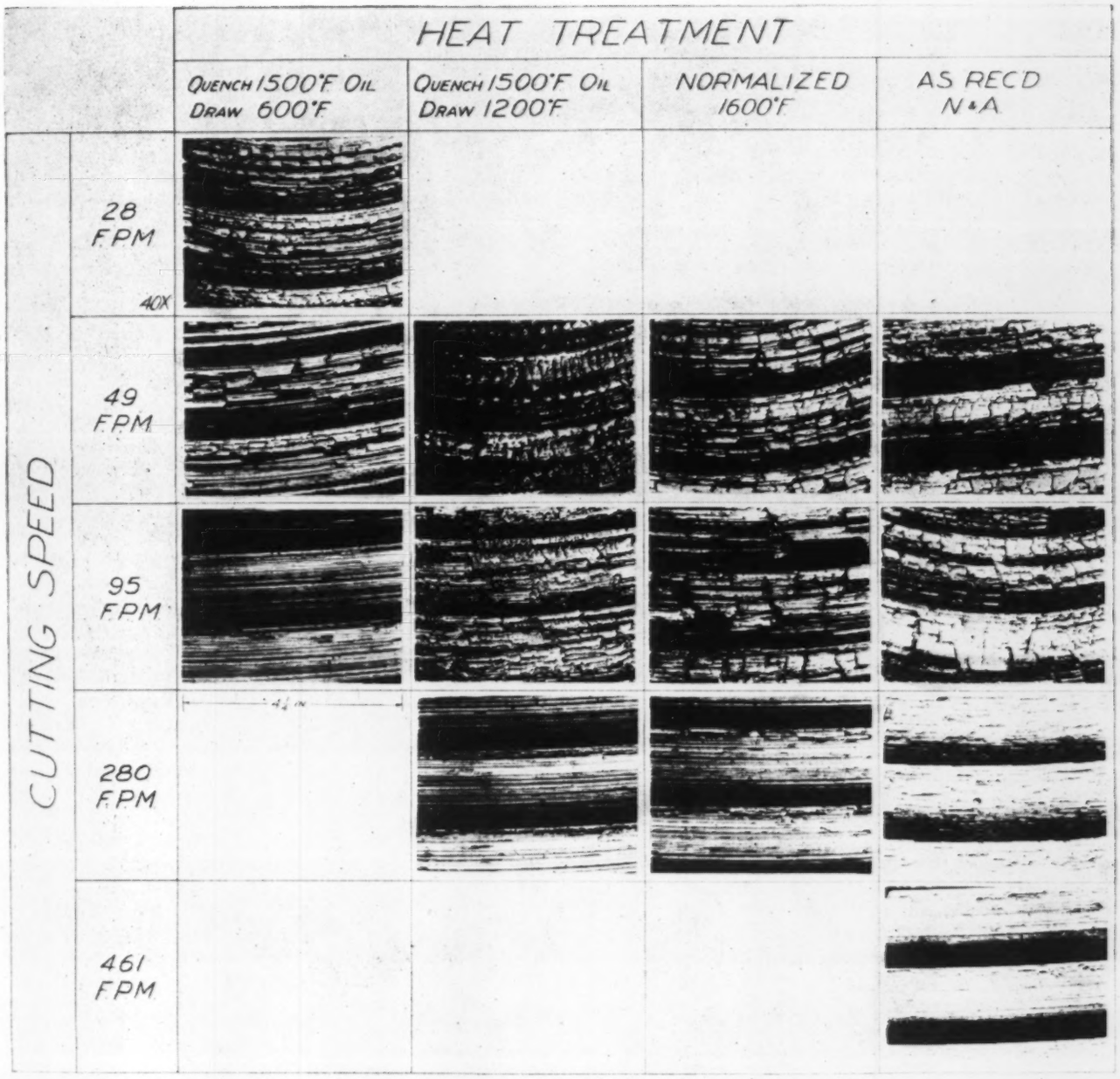

FIG. 7 SURFACE FINISHES ON S.A.E. 3140 STEEL

(Cut dry, facing cuts, using feed 0.0625 in. per revolution, depth 0.0035 in.; ×11.5.)

At the intermediate speed of 95 fpm, the specimen quenched at 1500 F and drawn at 1200 F, having a Brinell hardness of 255, had a finish greatly superior to the specimen normalized at 1600 F, having a Brinell hardness of 277.

From this study, it appears that a good surface quality can be obtained on the steel in any heat-treated condition, if the optimum speed is reached, but that the optimum speed to produce this best finish is lower for the harder steels.

GENERAL CONCLUSIONS

1 For the S.A.E. 3140 steel in a normalized-and-annealed condition, when cut dry, the surface quality produced at low cutting speed, as observed from photographs and profilograms, is poor. As high speeds are reached the surface quality is greatly improved. At a certain minimum speed, called the optimum speed, the cutting edge of the tool actually produces the machined surface which is superior to the surface at all lower speeds at which the chip is removed by means of a built-up edge. This same conclusion has been observed when turning an annealed S.A.E. 1045 steel.

2 Photographs, as well as profilograms, appear to show little difference in surface quality at high cutting speeds when various types of cutting fluids are used. At low speeds, however, it appears that the surface quality is improved over dry cutting when a cutting fluid, consisting of a sulphurized mineral or sulphurized base oil, is used.

3 The optimum cutting speed for each of several structures is lowest for the hardest steel and highest for the softest steel.

4 It appears also that the surface quality changes but slightly as the speed, cutting fluid, or structure is changed for values of cutting speed above the optimum.

EVALUATING COAL *in* COMBUSTION TESTS

AT THE Joint Meeting of the Fuels Division of The American Society of Mechanical Engineers and the Coal Division of the American Institute of Mining and Metallurgical Engineers held in Columbus, Ohio, October, 1939, Robert L. Rowan, fuel engineer of the General Coal Company, Philadelphia, Pa., pointed to the need for an authorized code designed primarily to govern combustion tests of coal in any of the several types of burning equipment.

Listing the development of tests designed to measure each of several qualities of coal, Mr. Rowan pointed out that these tests have been initiated by the needs of fuel engineers. Existing A.S.M.E. Power Test Codes are essentially tests of equipment and do not include more than incidental information concerning the fuel. Such information is largely corroborative of the equipment test which makes possible a heat balance and has, apparently, no further object.

The test of the equipment may satisfy the purchaser that the design is sound and production can be depended upon, but he is usually faced with a selection of coals on the next contract date and no code exists for the evaluation of each in combustion tests. The widespread nature of the need for such a code is indicated by the frequency with which papers on the subject of evaluating coals have appeared and the cooperative interest of the National Association of Purchasing Agents.

Mr. Rowan recognized that standardized tests have not yet been developed for certain qualities of coal and even that the measurement of additional qualities, the nature of which is at present unsuspected, may be necessary. The history of the laboratory test for ash-softening temperature illustrates the development of standardized tests to produce valuable information.

J. F. Barkley, supervising engineer, Fuel Economy Service, Bureau of Mines, stated that the classification of the details of the action of the fuel itself during combustion was a natural development of the progress of fuel engineering. Obviously, the combustion testing of coal will probably always be accomplished in a combination test, but the setting up of the additional data requirements will be as productive of valuable information in this field as it has been in others.

L. C. Bosler, former chairman of the A.S.M.E. Fuels Division, named specific coals with different properties which, under present code requirements, could be reported by the same data. The physical properties of coal, for which testing methods are now beyond the tentative stage, show the fuel engineer what may happen in transportation and furnace handling of coals.

Percy Nicholls, supervising fuel engineer of the Bureau of Mines, mentioned the existence of standard tests from which have been obtained the burning characteristics of cokes, anthracites, and coals in overfeed beds intermittently fired. He recognized the difficulty of finding definite characteristics and separating them from permanent and variable features of the equipment.

L. A. Shipman brought out the value of such a proposed code to the younger fuel engineers who have not yet lived long enough to acquire the experience which comes to the aid of the older men. It is not over-all results, given by existing codes, which are required but detailed data on the combustion process.

Engineers in the coal industry are not primarily interested in the efficiency of the coal-burning equipment but in the combustion characteristics of various coals which enable them to burn at maximum efficiency or with the greatest ease of operation or with lowest maintenance costs on equipment. According to R. F. Stilwell, fuel engineer for the Red Jacket Coal Sales Company, the primary object is to supply a coal which will produce the lowest production cost.

The great interest aroused at the meeting by Mr. Rowan's presentation of the need for a code for the evaluation of coal in combustion tests resulted in the immediate appointment by the chairmen of the respective divisions of the following representatives of each society to formulate plans for the establishment of such a code. The personnel of this joint committee is:

A.S.M.E. representatives: R. L. Rowan, General Coal Co., Philadelphia, Pa.; A. R. Mumford, Consolidated Edison Co., New York, N. Y.; A. W. Thorson, Chesapeake & Ohio Ry., Detroit, Mich.; L. A. Shipman, Southern Coal and Coke Co., Knoxville, Tenn.; Percy Nicholls, U. S. Bureau of Mines, Pittsburgh, Pa.; R. A. Sherman, Battelle Memorial Institute, Columbus, Ohio; R. M. Hardgrove, Babcock and Wilcox Co., New York, N. Y.; T. A. Marsh, Iron Fireman Corp., Chicago, Ill.; R. A. Foresman, Westinghouse Elec. and Mfg. Co., Philadelphia, Pa.; J. F. Barkley, Bureau of Mines, Washington, D. C.

A.I.M.E. representatives: R. L. Rowan, General Coal Co., Philadelphia, Pa.; J. E. Tobey, Appalachian Coals Inc., Cincinnati, Ohio; G. B. Gould, Fuel Engineering Co., New York, N. Y.; R. C. Rasmussen, Bell & Zoller Coal Co., Chicago, Ill.; M. A. Mayers, Carnegie Institute of Technology, Pittsburgh, Pa.; R. F. Stilwell, Red Jacket Coal Sales Co., Columbus, Ohio; Henry Kreisinger, Combustion Engineering Co., New York, N. Y.; E. J. Kerr, Island Creek Coal Sales Co., Huntington, W. Va.; and J. G. Bentley, Johnson-March Corp., Chicago, Ill.

This group held its organization meeting in Philadelphia in December, 1939, at the time of the A.S.M.E. Annual Meeting. Mr. Rowan was elected chairman and after considerable discussion a subcommittee on aims and objectives was appointed.

This subcommittee solicited and received the written opinions of committee members and others on the features required in the desired code and methods of setting up the code or codes. The chairman of the subcommittee, Mr. Thorson, reported at the second meeting of the main committee held in August at the Carnegie Institute of Technology in Pittsburgh.

The chairman appointed three subcommittees to formulate portions of codes dealing with:

1 Information required to describe the coal as supplied to the combustion equipment.

2 The observations to be made in tests to evaluate coal for use in underfeed stokers.

3 The observations to be made in tests to evaluate coal when burned in suspension.

The subcommittees as appointed stand as follows:

Subcommittee 1: R. F. Stilwell, chairman; J. F. Barkley; J. G. Bentley; G. B. Gould; R. C. Rasmussen; and J. E. Tobey.

Subcommittee 2: M. A. Mayers, chairman; R. A. Foresman; Percy Nicholls; L. A. Shipman; and A. W. Thorson.

Subcommittee 3: R. M. Hardgrove, chairman; E. J. Kerr; Henry Kreisinger; A. R. Mumford; T. A. Marsh; and R. A. Sherman.

Here, evidently, is an undertaking of great interest to producers, purchasers, and users of coal. All members of both societies affected by and interested in the project are urged to present their views to the general chairman, R. L. Rowan, either in writing or at this year's joint meeting to be held in Birmingham, Ala., Nov. 7–9, 1940. At this meeting a progress report will be made and opportunity afforded for open discussion.

The need for such a code is established. The interest is widespread. The preparation is under way.

Prepared by A. R. Mumford, Secretary, Fuels Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, as a basis for discussion at the Joint A.S.M.E.-A.I.M.E. Coal Meeting, Birmingham, Ala., Nov. 7–9, 1940. Comments are solicited.

MARKET ANALYSIS *From* MANAGEMENT STANDPOINT

By R. T. KENT

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THE object of management is to earn profits. To this end all tools that can usefully be employed should be employed. Market analysis is one such tool. Properly applied it will tell management where to concentrate its efforts:

(*a*) In the sale of its present products.

(*b*) In the improvement of its present products for the purpose of meeting or forestalling competition, or of stimulating the sale beyond the present limit.

(*c*) To ascertain whether or not products of the present line still have a continuing market appeal, or whether they are becoming obsolescent by reason of advances in the state of the art, or by the substitution of newer and improved products.

(*d*) To ascertain whether proposed new products will prove to be a profitable line and therefore should be developed and marketed or whether they will not make a sufficient return on the investment required to warrant the expense of development and marketing.

THE TWO PHASES OF MARKET ANALYSIS

It is evident, therefore, that market analysis falls naturally into two phases, the first of which relates to products at present manufactured and sold, and the second, to future products. From the management standpoint the first field is at the present instant the more important one. The profit resulting from the sale of products now being manufactured supplies the necessary capital for the development and marketing of the future products. It is assumed here that management does not propose to raise additional capital for the development and marketing of new products but will pay for these activities out of earnings. Furthermore, it is the profit resulting from the sale of present products that keeps the organization going and provides the money for pay rolls, materials, and other expenses incident to the operation of a going concern. Desirable as new products may be, from whatever standpoint they may be considered, it is highly essential that the sale of present products be kept at a point that will provide the necessary revenue for operation until a new product has been developed and has established itself in the market. Until it has done that, it cannot carry the burden of providing the necessary revenues.

The high mortality of once prosperous concerns has been the result, in many instances, of neglect of continuing market analyses of their products. An institution may be founded by a man who is a genius as an inventor, as a salesman, or as a business administrator. His product is well made and widely sold. It achieves a nation-wide reputation for excellence, and the organization grows until it becomes a large and important factor in the business world. The original associates in the enterprise retire or pass on. The business then is in the hands of others who may or may not have the genius in their respective fields that was had by the founder of the business. The momentum and the reputation may carry the business on without noticeable decrease in volume for quite a few years. The newcomers in the business are satisfied with both the products and the volume of business and, not recognizing the genius that founded it and built up its reputation, are content to drift. They are satisfied that with the reputation of the concern, business will come their way without any particular effort. In the meantime, however, competition has sprung up, headed by aggressive men with perhaps the same genius as the original founder, and they are slowly but surely undermining the solid position of the original firm. In the course of time the owners of this original firm wake up some fine morning to the fact that their volume has decreased and that many of their best customers have been lost forever. Desperate efforts and a complete change in the point of view may salvage the enterprise, but far too often the awakening comes too late and there is one more business added to the long list of those that once were great but could not keep up with the march of progress.

It is here that market analysis as regards present products plays its part. One form of market analysis is the ordinary sales forecast made annually, or preferably semiannually or quarterly, by an alert sales manager, and interpreted by an equally alert management. Such a forecast may take several forms, depending upon the nature of the business. It is not within the scope of this paper to outline the methods of making the forecasts or the forms which they should take. It is rather the idea to show how the interpretation of these forecasts by management has a direct effect on the future of the business.

THE CHARTING OF SALES DATA

Let us consider the case of a concern marketing three different products, which, while serving the same general field, necessarily are quite diversified in their characteristics, and each of which fulfills a distinctly different purpose. The forecast when made and charted alongside the forecast of similar products for several years preceding may reveal a number of interesting facts. Assume that product *A* shows a steadily increasing sale over a five-year period, and that product *B* had remained stationary as regards sales volume during the same period. Assume, further, that product *C* at the beginning of the five-year period showed a sales volume higher than that of either *A* or *B*, measured either in dollars or in units of product; assume further that the sale of *C* had steadily decreased and that the rate of decrease accelerated with each passing year. Alongside these figures might be presented, with advantage, several other sets of figures or facts, such as the dollar value of advertising during each period for each product; the number of salesmen employed on each product; the number of calls made per salesman, both the total and the average number per month. More important than the number of calls would be the number of actual interviews in relation to the product that was made by each salesman per year or per month. Another item of considerable informative value would be a tabulation of the number of prospective customers that were available for each of the

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three products during the period under consideration. Still another fact that would be informative is the number of competing firms manufacturing products similar to each of the three under consideration, and if the data could be obtained, the number of salesmen employed by them, the amount of advertising carried by each competitor, and other similar figures and facts regarding the competitors' activities. Many other data could be correlated; the data, however, would vary with the several kinds of business and the management would define for itself which were necessary in each case.

THE ANALYSIS OF SALES DATA

Having gathered all the data possible, let us see what they mean to management. Product *A*, let us assume, is relatively new; has plenty of advertising behind it; the salesmen are enthusiastic; and it is meeting a definite need. The margin of profit on each unit of sale is satisfactory and it need cause management no concern excepting to see that the present normal effort is maintained and that watch is kept over it to insure that it does not fall into the condition of product *C*.

The analysis of product *B* may reveal several things: It may be a perfectly satisfactory product but which, however, is serving a saturated market and that its uniform sale simply indicates a replacement demand. It may be quite evident that no extra amount of sales effort or advertising will stimulate any greater demand and that therefore things can be left pretty much as they are. However, this period of quiescence may be only the prelude to a rapid falling off in sales such as has occurred with product *C*. The analysis of this situation by management must take into consideration the fact that there may be competitive products coming into the field which are eating into what would be normally increasing sales of product *B*. It may indicate a sales management that is perfectly self-satisfied and is content to let things drift as they are, providing the revenues are up to normal and no effort is required to keep them there. These are only suggestions of the kind of things that management must look for when the volume of sales drifts along from year to year with inappreciable change. It may be stated almost as an axiom that business is never static. It is either growing or dying, and a static phase in any business usually is a precursor of a slow or quick death.

QUESTIONS FOR MANAGEMENT TO ASK

The condition of product *C* indicates that quick and drastic steps are necessary. Without any elaboration of detail let us say that management should ask itself the following questions in regard to product *C*:

1 Is the sales management as regards this product alert and progressive?

2 Is the sales effort including advertising and personal solicitation adequate?

3 Is the product itself of the type, character, and quality that will meet the demands of the existing market?

4 Is the price of the product competitive?

5 Are the costs of manufacture sufficiently low to enable the product to be marketed at a profit and still leave sufficient margin for proper sales effort?

6 Does the same market exist for the product as existed five years ago? That is, has an entirely new type of product taken its place? For example, a number of years ago the oil lamp was necessary in every home, while today it has been almost completely displaced by electric light.

7 Has the state of the art made the product obsolescent?

8 Have competitors brought out new designs that have greater market appeal, not only from the standpoint of utility and convenience but of appearance?

The answer that management will find to any or all of these questions and to many more which it could ask itself will indicate the course to be pursued. If the product is in the category of the oil lamp attempting to compete with electricity, the obvious course is to liquidate that portion of the company's activities as rapidly as possible, before what little margin of profit may remain in it is turned into an irrecoverable loss. If the sales management is at fault, a check up in the sales department should follow forthwith. If competitors with newer and better products are undermining the sales volume, a redesign of the product is imperative.

Superimposed on all of these remedies the management must have in the back of its head all of the time the question as to whether or not the expenditure required to accomplish the objects desired will be recovered in a reasonable time and in sufficient volume to make the expenditures worth-while. If the answer to this question is negative, then again is prompt liquidation indicated.

THE FORGOTTEN PRODUCT

The foregoing eight questions in relation to product *C* also may be asked profitably in connection with products *A* and *B*. In short, management should at all times be fully conversant with everything concerning not only its own product, but those factors which may affect that product's position in the competitive market. In many cases the sales forecast, on which the analysis just discussed was based, is not always sufficient to give management the information it needs in order to formulate policy. For example, a certain product may at one time or another have represented a considerable volume of sales. In the course of years, owing to some of the causes just enumerated, it has been almost forgotten in the minds of the sales department as a possible source of revenue. It has been so long since consistent effort has been made to sell this particular product that no one in the present organization has sufficient knowledge of the sales possibilities to be able to render an accurate opinion as to future sales possibilities. It is quite possible that the original purpose of this product has passed quite out of the picture, which may account for its disappearance from the sales setup. It is also quite possible that during this same period, or subsequent to it, new uses for this product have developed and are furnishing a good market for competitors. Under such circumstances it may be advisable for the management to call in an expert market analyst to survey the possibilities of resuscitating this product into a profitable line.

THE FIELD OF THE MARKET ANALYST

The market analyst also may serve a useful purpose in connection with the study of the sales forecasts of the standard product such as we have just been considering. The horizon of the average sales manager is somewhat limited. He may know and see very clearly the entire field for which his product naturally is adapted. Owing to his unfamiliarity with other fields of endeavor he may not know of still wider possibilities of sales in fields and industries of which he has little or no knowledge. The expert market analyst, rightly employed, may open up possibilities of sales far in excess of those that are at present considered as highly satisfactory.

MARKET ANALYSIS OF A NEW PRODUCT

Market analysis is generally considered as relating to new products. It is the author's belief that while this phase of market analysis is highly important, and in fact so important that no new product should be attempted without it, nevertheless, it is the market analysis as applied to the present products that is most important, because these insure the "bread and butter" of the enterprise.

(*Continued on page 799*)

MOLYBDENUM *in* IRON *and* STEEL

By THERON D. PARKER

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ELEMENTS which are purposely added to modify some property or combination of properties in iron or steel are referred to as alloying elements and the ferrous product containing these modifying elements is called an alloy iron or an alloy steel.

The reasons for using alloying elements may vary with the individual and his position in the industry. However, the foundryman, the engineer, and the metallurgist have a common purpose in mind, namely, to produce a more serviceable product at the lowest over-all cost.

The advantages of alloy irons and steels from the engineering standpoint might include any one or all of the following:

1 Permit reduced maintenance and replacement cost. This includes such items as:

(*a*) Cost of the material
(*b*) Cost of fabrication—includes heat-treating and machining costs
(*c*) Maintenance expense
(*d*) Replacement cost—includes loss of production and attendant expenses while installing new parts.

2 Permit reduction in weight, thereby allowing greater pay loads. In the case of heat-transfer equipment light sections mean higher efficiency, thus lower operating costs.

3 Permit operation at higher temperatures and pressures. Result: Higher plant efficiency and often a better product at a lower cost.

4 Permit lower operating temperatures. Result:

(*a*) New manufacturing processes which were hitherto commercially impossible
(*b*) Greater factor of safety in machines that operate in cold climates.

5 Give improved response to heat-treatment. Alloy steels require less drastic quenching treatments to develop the required physical properties, thus reducing stress concentration and minimizing the danger of failure owing to cracks developed during heat-treatment.

Space does not permit a discussion of all the molybdenum irons and steels that are employed by industry. It therefore becomes necessary to review some of its more general effects and discuss its use in a few of the common groups of engineering alloys.

HISTORY

Molybdenum is one of the newer metals to gain importance as an alloying element. Its presence as an alloy with iron dates back to the fourteenth century. It was during this period that a craftsman, Masamune, in Japan, made swords that were known for their outstanding beauty and effectiveness. The ownership of these swords was a matter of pride and a great honor. They were handed down through the centuries, but it was not until the early part of the present century that a metallurgist analyzed one of the swords and found it to contain the element molybdenum along with numerous other metals. Undoubtedly, molybdenum was present in the ore used in the production of the swords. In 1831 an analysis of a meteor disclosed the presence of this element. The first record of the intentional use of molybdenum in steel dates back to 1894, when the Creusot Works of Schneider et Cie studied its effects. Later this company produced quantities of molybdenum-containing steel. The metal was introduced into this country about 1899 and as early as 1904 molybdenum-bearing tool steel won a prize at the World's Fair in St. Louis.

Owing to the high price and uncertainty of supply, growth in the use of molybdenum in this country was slow for the next ten to twelve years. Following the temporary demand for molybdenum during the World War, investigations were conducted which led to the specification of molybdenum steels for peacetime uses. This was followed by a gradual decline in the price of molybdenum. Continued research by those interested in the alloy-steel industry gradually brought about the adoption of molybdenum steels in the general engineering field and, as a result, the world consumption of molybdenum has grown from less than seven million pounds in 1933 to some thirty-five million pounds in 1939.

The largest known ore deposits are in our own country and include, besides the property at Climax, Colo., deposits in Arizona, Idaho, New Mexico, and Utah. Some molybdenum is also produced in Mexico, Norway, Turkey, Canada, Africa, and Alaska.

The element molybdenum is generally found combined with either sulphur or with lead. Of these two compounds the former is of greater interest since this mineral is more commonly found and therefore it is the one from which commercial molybdenum products are generally converted. The discussion will therefore be confined to molybdenum sulphide or molybdenite. The Greeks first observed this mineral and gave it the name "molybdos," meaning lead-like since it resembles lead or galena. Carl Wilhem Scheele, a Swedish chemist, was the first to observe that the substance, then called molybdena, contained an elementary metal, and in 1782 his contemporary, Hjelm, succeeded in producing the pure metal, which is silvery white, soft, and quite malleable. It has an atomic weight of 96 and a melting point of 4748 F.

The refining of molybdenum from the mineral molybdenite is accomplished by crushing the ore and recovering the molybdenum sulphide by flotation. Commercial molybdenite concentrates produced by this process generally contain in excess of 80 per cent molybdenum sulphide. After roasting the sulphide to the oxide of molybdenum the concentrate is either alloyed with iron or combined with lime, forming the two common products, namely, ferromolybdenum and calcium molybdate, both of which are basic materials used in the alloying of iron and steel.

Recent developments have led to the use of molybdic oxide either in powder form or in the form of briquettes. The briquettes contain a pitch binder and are a self-reducing mixture. Both canned oxide and briquettes are used for making molybdenum additions to the cupola, electric, open-hearth, or air furnaces. The use of calcium molybdate is confined to the electric, open-hearth, and air-furnace melting practice, where the additions can be made either with the charge or shortly after the meltdown. Ferromolybdenum of suitable size is regularly used for both furnace and ladle additions.

Presented at a meeting, New York, N. Y., Jan. 30, 1940, of the Metropolitan Section, The American Society of Mechanical Engineers.

MOLYBDENUM CAST IRON

Small amounts of molybdenum were used in chilled rolls for the steel industry as early as 1924. However, the broad use of this metal as an alloying element in cast iron really began about 1929. Since that time the use of molybdenum has rapidly increased until today engineers, metallurgists, and foundrymen are familiar with many of its applications.

The benefits resulting from the addition of molybdenum to cast iron are primarily due to its solid solution and mild carbide-forming characteristics. It also breaks up the graphitic structure and tends to produce a shorter curled flake. While it is advisable to resort to the use of alloying elements only after development of the best base-iron possible, molybdenum will give improved physical properties in almost all classes of iron without changing from the regular furnace charge and melting practice. Whether used alone or in conjunction with other alloying elements—such as chromium, nickel, copper, and vanadium—it is the most effective means of increasing the tensile strength of cast iron. The degree of improvement in tensile strength depends upon the quality of the base iron and the amount of molybdenum added and may vary from as little as 5 per cent to as much as 50 per cent. The increase in tensile strength is usually accompanied by an increase in transverse and impact strengths. It does not necessarily follow that machinability is decreased; in fact, it is often observed that for a given hardness and tensile strength molybdenum improves machinability.

Molybdenum irons have a higher modulus of elasticity than plain irons of the same base analysis. Data indicate that the improvement in the modulus is proportional to the increase in tensile strength.

Molybdenum, like other alloying elements, has little effect on the coefficient of expansion of gray iron. The tendency is to lower this figure—but only about 5 per cent. Linear or patternmakers' shrinkage is reduced by the addition of molybdenum; hence, in castings of varying and intricate section its use has reduced foundry rejects resulting from cracks.

Molybdenum has also found wide application in castings that are subjected to elevated temperatures. Benefits derived from its use in this field can be summarized as follows:

1 Retards the rate of structural changes, thereby tending to equalize stresses caused by uneven temperatures.

2 Gives improved strength and toughness at both room temperature and elevated temperatures.

3 Aids in the dispersion of carbides and refines both the grain structure and the distribution of the graphite.

4 Adds slightly to carbide stability.

Chromium or vanadium is usually used with molybdenum for high-temperature applications to give added carbide stability, thereby reducing growth in service.

Cast iron is well known for its fine damping characteristics. The addition of any alloying element which increases the hardness and strength of iron will reduce the damping effect. The damping capacity of high-strength irons is, however, much superior to steels, and irons having tensile strengths in excess of 50,000 psi are being successfully used for many parts which were previously made of steel. For instance, cast-iron gears, besides possessing remarkable wear resistance, have assisted in the elimination of noise in gear trains formerly made of steel.

No general claims can be made relative to molybdenum and its effect on the corrosion resistance of cast iron. Only when used in conjunction with other elements, especially copper, does it have commercial application on this basis. Data do not indicate, however, that it detracts from the otherwise good corrosion resistance of unalloyed gray iron.

Possibly one of the most important uses of molybdenum in iron rests in those applications requiring improved wear resistance. The pronounced refinement in grain structure, combined with the strengthening and toughening action of the alloying element, are responsible for its wide use in this field. Examples include such castings as liners, motor blocks, gears, cam and crank shafts, pump castings, dies, and mill guides.

For the last several years there have been numerous discussions and papers given on the subject of heat-treated irons. The primary purpose of heat-treatment is to increase the usefulness of iron castings. Fundamentally, three types of treatment are applied, namely, strain-relieving, annealing for machinability, and hardening for greater wear.

Molybdenum additions to irons that are heat-treated:

1 Permit higher strain-relieving temperatures
2 Reduce cracking and distortion
3 Increase depth hardness
4 Give added structural stability.

MOLYBDENUM STEELS

The general commercial use of molybdenum steels began in 1922, when Studebaker Corporation specified chromium-molybdenum steels for drive rods; Hyatt Roller Bearing Company, chromium-molybdenum steels for roller-bearing strip; and The Timken Roller Bearing Company, nickel-molybdenum steel for carburized rolls and races. This forward step in the application of molybdenum led to the present S.A.E. specifications for 4100 chromium-molybdenum steels and 4615 nickel-molybdenum carburizing steel in 1925. The nickel-molybdenum series was later enlarged to include S.A.E. 4620 and 4640. Two more S.A.E. series, known as 4300 nickel-chromium-molybdenum steel and 4800 nickel-molybdenum carburizing steels, have also been adopted, so there are at present thirteen different molybdenum-containing steels standardized by the Society of Automotive Engineers. The analysis range for each type may be found in the various engineering and metallurgical handbooks.

The versatility and comparatively low cost of the chromium-molybdenum steels have caused them to become a most popular type. S.A.E. X4130, well known for its good weldability in light sections and high weight-strength ratio, is extensively used in sheet and tube form by the aircraft industry. Bar stock is also employed both for aircraft and for general engineering applications. In welding light sections of this steel the oxy-acetylene process is recommended, while for heavier sections electric arc welding is sometimes employed. The higher-carbon steels—S.A.E. 4140 and 4150—are widely specified for gears, pinion shafts, drive shafts, crankshafts, collets, arbors, spindles, and tools, in the machine-tool and automotive industries. The American Society for Testing Materials—Specification A193-39T—includes S.A.E. 4140 steel for bolts and studs operating at 750 to 1100 F.

Forgings and miscellaneous parts—drill collars, tool joints, Kelly bars, draw-work shafts—in oil-well production equipment are made of S.A.E. 4140 and 4150. These steels also possess good low-temperature properties in the heat-treated condition and find application in this field.

A discussion of the chromium-molybdenum steels would not be complete without mention of the low-carbon carburizing type. While this steel is not listed among the S.A.E. types, it is being applied as a low-cost steel in a number of places where the fine properties of the S.A.E. 4600 carburizing steels are not necessarily required. (Examples: Hypoid gears, industrial-truck drive gears, wash pipe in drilling equipment.)

Nickel-molybdenum steels are well known for their low distortion characteristics during carburizing and oil hardening treatments. The low-carbon types are extensively used for carburized parts where a hard, tough, and wear-resistant case is

desired. Owing to the molybdenum content (8)[1] and the melting practice employed the nickel-molybdenum carburizing steels possess a high grain-coarsening temperature, thus minimizing the danger of grain growth during carburizing. This makes it possible to quench these steels directly from the carburizing temperature and maintain a fine grain structure which is necessary in both the case and core if the maximum serviceability is to be obtained. This eliminates both time and expense in the heat-treating department. In some cases these steels are reheated to 1425–1525 F and given a second quench to further refine the structure and develop additional toughness. In general, the core hardness of the double-quenched steel is not quite as high as that of the single-quenched material.

Oil-hardening steels of the nickel-molybdenum type when hardened to 400–550 Brinell possess toughness and wear-resisting characteristics which make them advantageous for cams, gears, and the like. Shafts and pinions made from these steels are usually treated to a lower hardness to give a further improvement in toughness.

Nickel-chromium-molybdenum steels of the S.A.E. 4300 type are primarily designed for heavy sections and highly stressed parts, many of which do not lend themselves to the use of water-hardening steels. These steels respond to both air-cooling and oil-quenching treatments and develop good ductility and toughness combined with a high yield-tensile ratio. S.A.E. 4320 is used for highly stressed carburized parts. It develops a relatively high core hardness, which is desirable if the case is subjected to heavy loads.

Numerous types of molybdenum steels outside the S.A.E. range are often employed for special applications. These steels may contain molybdenum alone or combined with any or all of the elements, nickel, chromium, vanadium, and copper.

HIGH-TEMPERATURE STEELS

High-temperature steels and molybdenum have become kindred subjects as a result of the broad application of molybdenum steels wherever elevated temperatures are encountered. This is due largely to the pronounced increase in creep strength which accompanies the addition of molybdenum. While the effect of molybdenum is progressive, larger amounts have not been found to increase the creep strength as rapidly as small additions. For operating temperatures up to about 1000 F molybdenum may be the major alloying element present in the steel. For higher temperatures, chromium or chromium with increased silicon content are used with molybdenum to give the necessary increase in corrosion and oxidation resistance. In some of these steels the molybdenum content is raised from the customary range of 0.40–0.60 per cent to as high as 1.50 per cent to give added resistance to creep and reduce temper brittleness.

Space does not permit a discussion of the various analyses that are produced, but an idea of the range of creep strength (3) and oxidation resistance (4) of several steels can be obtained from Table 1.

Fig. 1 (4) shows the effect of silicon on the oxidation resistance of chromium-molybdenum steels, while Fig. 2 (4) gives the creep strength of molybdenum steels containing 5.00 per cent chromium and 0.50 per cent molybdenum and different amounts of silicon.

The chart shows the low-silicon steel to have better resistance to creep than the high-silicon steel at 1000 F, but this difference becomes negligible at 1200 F. There is, however, an advantage in the high silicon content owing to its beneficial effect on the oxidation resistance at the higher temperatures.

From the foregoing it is evident that by careful selection of the chromium, silicon, and molybdenum contents, an analysis can be developed to meet a wide variety of operating conditions. Extensive research and field experience has permitted a large number of alloy combinations to become standard materials, so it is now possible for the engineer to place his problem before the steel company or the fabricator and they, in turn, can select that anslysis best suited for the job.

The use of carbon-molybdenum steel plate for boilers and other pressure vessels is an application that has received considerable attention during the last few years. In 1938 The American Society of Mechanical Engineers adopted specification S-44 covering three grades of carbon-molybdenum steel for this purpose. The American Society for Testing Materials has since adopted a similar specification A-204-39. As a result of these specifications and the increased use of carbon-molybdenum steel plate, The American Society of Mechanical Engineers has recently revised the allowable working stresses for carbon and carbon-molybdenum steel for temperatures up to 1000 F. These data are shown in Table 2.

The improvement in physical properties at temperatures above 650 F resulting from the addition of 0.40 to 0.60 per cent molybdenum makes it possible to use these steels at higher temperatures than carbon steel. This may result in improved efficiency of the equipment. It also permits a reduction in section thickness, thus improving the ease of fabrication—this all means added economy.

Reference has been made previously to the presence of molybdenum in tool steels as early as 1904. Owing at least in part to the high cost of molybdenum and an inadequate source of

TABLE 1 THE CREEP STRENGTH AND RELATIVE RESISTANCE TO OXIDATION OF SEVERAL CHROMIUM-MOLYBDENUM STEELS

Composition	Creep strength (3), 0.01 per cent per 1000 hr, 1000 F	1100 F	1200 F	Relative oxidation (4), 1200 F
Carbon	2150	..	..	100
Carbon —0.50% Mo.	5200	..	..	115
2.00% Cr—0.50% Mo.	6300	3325	1100	50
3.00% Cr—0.90% Mo.	7000	4200	..	35
5.00% Cr—0.50% Mo.	7200	2400	900	25
9.00% Cr—1.15% Mo.	8500	3775	1600	11

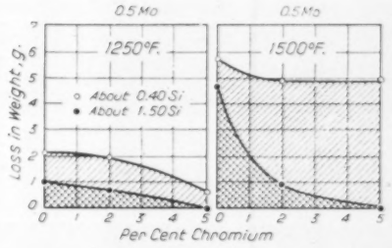

FIG. 1 EFFECT OF SILICON ON THE OXIDATION OF LOW CHROMIUM-MOLYBDENUM STEELS (4)

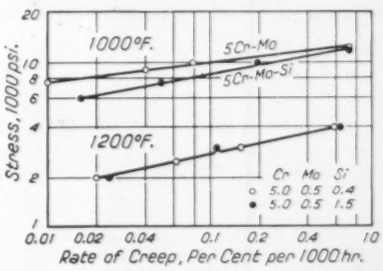

FIG. 2 CREEP OF 5 PER CENT CHROMIUM-MOLYBDENUM-SILICON STEELS AT 1000 AND 1200 F (4)

[1] Numbers in parentheses refer to Bibliography at end of paper.

TABLE 2 MAXIMUM ALLOWABLE WORKING STRESSES FOR CARBON AND CARBON-MOLYBDENUM STEEL PLATE AS SPECIFIED BY A.S.M.E. (13)

Type of steel	A.S.M.E. spec No.	Grade	Min ts, psi	Max allowable working stress for metal temperature not exceeding F: −10 to 650	700	750	800	850	900	950	1000
Carbon	S-2	A	45,000	9,000	8,800	8,400	6,900	5,700	4,400	2,600	...
	S-2	B	50,000	10,000	9,600	9,000	7,500	6,000	4,400	2,600	...
Carbon	S-26	A	65,000	12,000	12,300	11,100	9,400	7,600	5,600	3,800	2,000
	S-26	B	70,000	14,000	13,300	11,900	10,000	7,800	5,600	3,800	2,000
Carbon-moly	S-44	A	65,000	13,000	13,000	13,000	12,500	11,500	10,000	8,000	5,000
	S-44	B	70,000	14,000	14,000	14,000	13,500	12,000	10,200	8,000	5,000
	S-44	C	75,000	15,000	15,000	15,000	14,400	12,700	10,400	8,000	5,000

supply, widespread standardization did not take place at that time.

The commercial use of high-speed steels containing molybdenum instead of tungsten began in Germany during the War. The Watertown Arsenal instigated a study of molybdenum high-speed steels in 1930. This was followed by extensive investigations by numerous interested parties and, as a result, molybdenum containing high-speed steels have found increased use in tools that were previously made of tungsten steels of the 18-4-1 type

HIGH-SPEED STEEL

It has been demonstrated that, at least within limits, tungsten can be replaced by molybdenum on the basis of about one part of molybdenum for each two parts of tungsten. The result is that there are now several commercial types of high-speed steel which contain molybdenum as the major alloying element. These steels are successfully competing with tungsten steels on a performance basis. In one type, about nine tenths of the customary tungsten content is replaced with about one half as much molybdenum. The steels of this type generally contain from 8.00–9.50 per cent molybdenum, 1.25–2.00 per cent tungsten, with the usual 4 per cent chromium and 1 per cent vanadium. Another type, which is substantially tungsten-free, contains from 7.50–9.50 per cent molybdenum and 1.00–2.50 per cent vanadium, with the usual chromium content. By adding cobalt or increasing the carbon and vanadium contents the cutting life of tools made from the aforementioned steels may be increased.

The cutting properties of properly treated tools made from the foregoing types of steel are comparable to those ordinarily obtained with tungsten steels.

As in the case of tungsten steels, the hardening temperature for molybdenum high-speed steels will vary with the analysis and the type of tool. In general, however, the proper hardening temperature is lower for the molybdenum steels. The lower temperature, plus the resistance of molybdenum steels to any physical-structural change, makes it necessary to allow increased time at the hardening temperature to insure uniform response from the treatment.

All of the foregoing types of molybdenum steels have a greater tendency to decarburize than tungsten steels. It is, therefore, more necessary to protect the surface of these steels during forging, rolling, and heat-treating operations. This can be done by the use of surface coatings—of which borax is one—or by employing controlled-atmosphere furnaces. Salt baths are also successfully used for hardening.

A more recent type of molybdenum high-speed steel, containing 4.00–6.50 per cent molybdenum and a like amount of tungsten, has an advantage in that it is not subject to decarburization during fabrication and heat-treatment to as great an extent as the steels previously referred to. The addition of about 2.50 per cent copper practically eliminates the remaining tendency of the steel to decarburize. The carbon and vanadium contents are often increased to give steels with increased cutting capacity. The higher carbon and vanadium contents also promote greater resistance to abrasion.

With these several types of high-speed steel industry has available a molybdenum steel suitable for practically any cutting application that has in the past been met with steels of the tungsten and tungsten-cobalt types. The lower cost of the molybdenum steels, combined with the fact that, owing to the lower density, from 7–10 per cent more tools can be produced from the same weight of steel, has caused tool engineers and shop superintendents to investigate these alloys, with the result that there has been a rapid growth in the use of molybdenum steels for cutting tools.

MOLYBDENUM IN HIGH-CHROMIUM AND CHROMIUM-NICKEL ALLOYS

In the family of high-chromium steels—those containing 12 per cent or more chromium—there are a number of types containing 0.50 per cent or more molybdenum. It has been observed that the presence of this element assists in refining the grain and improving the machinability of these steels. It also improves the impact properties and under certain conditions enhances the corrosion resistance.

The presence of 2.00–4.00 per cent molybdenum in stainless steels of the 18-8 type has extended the successful application of these steels as a result of the improved resistance to chemical attack. The molybdenum-containing stainless steel is extensively employed in the sulphite paper and textile industries. Recent tests (10) show the molybdenum types to resist attack by sea water to a much better degree than the straight 18-8 types. In general, the molybdenum types show improved resistance to practically all forms of corrosion but this improvement is not always sufficient to warrant the extra expense. It is, therefore, advisable to test both types unless the conditions present are accurately known and previous experience makes it possible to select the best analysis.

EFFECT OF MOLYBDENUM IN PEARLITIC STEELS

The benefits derived from the use of molybdenum in steels are related directly to its solid-solution and carbide-forming characteristics, since molybdenum does not act as a deoxidizer. Structurally, the effect of molybdenum appears to be one of grain refinement and restraint of austenite grain growth (8). Molybdenum steels can be heated to higher temperatures during forging, rolling, and heat-treating operations with reduced danger of grain growth. The free-scaling characteristics of many of the molybdenum steels make them advantageous in the forge shop. Absence of the abrasive scale promotes longer die life. It has been noted that molybdenum steels flow well under the hammer. However, the retention of strength of molybdenum steels at high temperatures results in increased stiffness. This makes it desirable to employ fairly high forging temperatures.

Molybdenum, like other alloying elements, does not greatly affect the maximum hardness obtained by quenching, but it does have a pronounced beneficial effect on the hardenability, as will be shown later. Bain (12) has shown that 0.50 per cent molybdenum in a 0.35 per cent carbon steel increased the maximum hardness obtained after quenching by only two points on the Rockwell C scale. In the same chart he showed that the same small increase in hardness could be obtained with about 1.25 per cent chromium.

Molybdenum steels generally require a higher drawing tem-

perature after hardening than unalloyed and alloyed steels not containing this element. Bain (12) has shown that 0.50 per cent molybdenum added to a 0.35 per cent carbon steel makes it possible to increase the drawing temperature 75–250 F for a given hardness. A similar condition exists when molybdenum is added to a 2 per cent chromium steel. See Fig. 3 (12). The higher permissible drawing temperature allows a more complete release of internal stresses, resulting in increased toughness—a well-known characteristic of molybdenum steels.

The sluggishness of molybdenum steel to any physical-structural change makes it advisable to give steels containing this

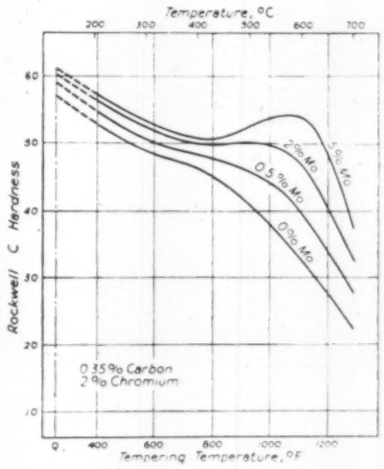

FIG. 3 INFLUENCE OF MOLYBDENUM ON THE RESISTANCE TO SOFTENING WITH INCREASING DRAWING TEMPERATURE OF 2 PER CENT CHROMIUM, 0.35 PER CENT CARBON STEELS (12)

element a thorough soak at temperature before quenching and forging operations.

Temper brittleness is practically eliminated by the addition of molybdenum. This makes the element particularly advantageous in steels used for heavy sections where it is inconvenient to resort to the use of liquid quenching from the drawing temperature. The amount of molybdenum required depends on the balance of the analysis and the amount of other alloying elements present.

HARDNESS PENETRATION AS AFFECTED BY MOLYBDENUM

A number of hardenability tests have been designed during recent years to give comparative data on different analyses. Numerous papers have been written describing these tests and giving useful information on the subject of hardenability. A more fundamental approach to this subject can be made by studying the temperature vs. isothermal-reaction-rate curves, sometimes called "S-curves," for carbon and alloy steels. We are indebted to Davenport and Bain (1) for this method of analysis which gives information on the rate of austenite decomposition of steels isothermally transformed at subcritical temperatures. It also permits a detailed study of the structure and physical properties of the various products formed by these isothermal treatments.

It is not the purpose of this paper to describe the procedure required to develop the necessary data to plot the temperature vs. isothermal-reaction-rate curves. Those interested in this subject should review papers written by Davenport and Bain (1, 9), Griffiths, Pfeil, and Allen (7), Parke and Herzig (11), Legge (6), and others. We shall concern ourselves primarily with the effect of carbon and molybdenum on the position and form of the reaction-rate curve and by so doing attempt to illustrate another important function of molybdenum in steel, namely, its effect on hardness penetration.

There are two significant portions of the temperature vs. isothermal-reaction-rate curve that will be considered. The first is that portion of the curve lying between the constant-temperature lines of about 900–1100 F and often referred to as the nose of the curve. It is within this range that rapid decomposition of austenite occurs. Pearlitic structures which form above this temperature range begin to give way to the more acicular structures in this range and therefore it might be said the nose of the curve roughly divides the pearlitic from the acicular products of austenite decomposition.

The position of this portion of the curve in relation to time, plotted as the abscissa, largely governs the hardenability of steel. If the time for initiation of austenite decomposition within this temperature range is short, it follows that the steel is shallow hardening since it would be impossible to cool a sizable section rapidly enough to prevent austenite decomposition above the nose.

The second significant portion of the curve lies between the constant-temperature lines of 900 F down to some 300–400 F. The decomposition products formed within this temperature range are acicular in nature and possess a degree of toughness which is not present in the products of austenite decomposition below this range (2, 5, 6). The decomposition products formed within this range are harder than those formed at the higher temperatures. In general, the hardness increases as the temperature of isothermal transformation decreases. However, there is a temperature interval between about 1100–800 F within which some steels show relatively little change in the hardness of the decomposition products (9, 11). In order that a steel may have deep-hardening characteristics and still develop acicular products which possess a relatively high degree of ductility, two conditions must be present:

1 The nose of the curve must be far enough to the right—in the direction of increasing time—to permit the steel to be cooled in the section desired through this temperature range with a minimum of austenite decomposition.

2 The reaction-rate within the temperature range of about 900–400 F must be sufficiently rapid to allow transformation to go to completion before the steel is cooled to a temperature below about 400 F. This can be assisted in practice by employing austempering or time-quenching practices.

Fig. 4, taken from work by Davenport (9), shows that the position of the reaction-rate curve may be altered by varying the carbon content of a steel. The figure shows two sets of curves. Those on the left represent the time required for the beginning of the pearlite reaction in isothermally treated speci-

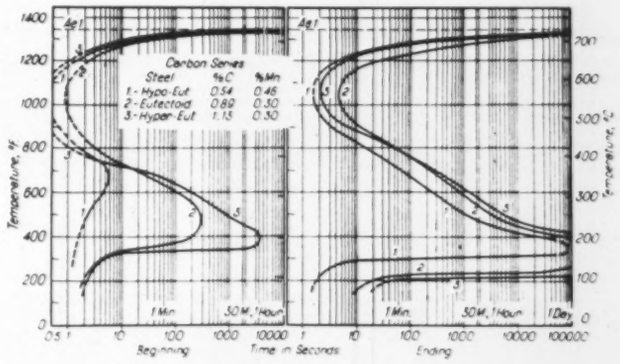

FIG. 4 INFLUENCE OF CARBON ON THE ISOTHERMAL-REACTION-RATE CURVE

[Left: Beginning curve. Right: Ending curve (9).

mens of the three steels tested, while those on the right represent the time required for complete decomposition of the austenite. The curves show that decreasing the carbon content below that of the eutectoid composition causes the nose of the curve to be displaced to the left. Low carbon contents also restrict the austenitic area in the temperature range of 800 to 300 F, thereby tending to force transformation to take place within this temperature range, assuming that the steel can be cooled in excess of its critical quenching rate. Owing to the speed of austenite decomposition at about 1000 F, it is evident that this is commercially impossible, in low- and medium-carbon unalloyed steels.

Carbon contents in excess of the eutectoid composition (curve No. 3) caused the nose of the reaction-rate curve to be displaced to the left, while concurrently the time required for initiation of transformation at 600 to 400 F is greatly increased. The lower portion of the curve, besides being extended to the right in high-carbon steels, is moved to a lower position on the temperature scale. It follows that if the steel is cooled in excess of its critical quenching rate the austenite will remain stable down to lower temperatures and the final products of decomposition will be harder.

It has been shown (12) that the maximum hardness obtained by quenching a 0.20 per cent carbon steel is 525 Vickers pyramid hardness, while that of a 0.50 per cent carbon steel is 825 Vickers pyramid hardness—an increase of 300 points. It has also been stated (12) that alloying elements have relatively little effect on the maximum hardness obtainable by quenching. We must therefore look to carbon for intensity of hardening, and to alloying elements to increase the depth of hardening.

Davenport (9) has worked out reaction-rate curves for medium-carbon steel containing from 0–2.00 per cent molybdenum. (See Fig. 5.) It is clearly evident that molybdenum has a pronounced effect on the position and form of this curve. It has been reported (9) that molybdenum contents up to 0.50 per cent are more effective in retarding transformation above 1000 F than chromium, which in turn is more effective than manganese, carbon, or nickel. The curves do not show any pronounced difference for steels containing approximately 0.50–0.80 per cent molybdenum. This may possibly be due to lower carbon and manganese contents of steel 4 as compared with steel 3. The dotted curve, however, for 1.96 per cent molybdenum, which must be considered as tentative, suggests that in the higher molybdenum contents pronounced changes in the temperature and the rate of transformation occur.

It will be recalled that in carbon steel of eutectoid composition the maximum rate of transformation occurred at about 1000 F. The maximum rate of transformation in the molybdenum steels studied occurred at 850–900 F, or 100–150 F lower. It can also be seen that the initiation of austenite transformation is relatively rapid within the temperature range of 700–500 F for the molybdenum series studied. In fact, it is more rapid than for the unalloyed steel containing 0.54 per cent carbon shown in Fig. 4. This may be caused by the lower carbon content of the molybdenum steels studied. The conclusion might be drawn at this point that molybdenum displaces the nose of the curve in the direction of increasing time, thereby decreasing the critical cooling rate necessary for full hardening. It is undoubtedly this action of molybdenum which accounts for the remarkable depth-hardening effect which it has in steel. Molybdenum contents—up to at least 0.80 per cent—seem to have relatively little effect on the position of the lower portion of the curve, indicating that the presence of this element does not hinder the initiation of austenite decomposition once the steel is cooled past the nose of the curve.

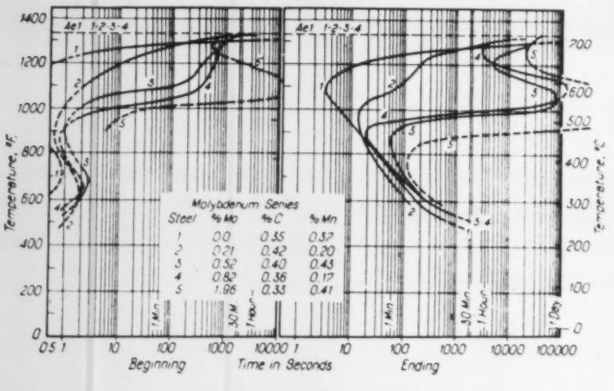

FIG. 5 INFLUENCE OF MOLYBDENUM ON THE ISOTHERMAL-REACTION-RATE CURVE

[Left: Beginning curves. Right: Ending curves (9).]

To some of the readers of this discussion it may seem that the reaction-rate curves for steels are useful only when using isothermal treatments, since they are developed from data obtained by employing this method of treatment. Actually, they can be used in applying any type of heat-treatment providing the cooling rate of the particular section is known. The curves give the time required for austenite decomposition at subcritical temperatures and by superimposing the cooling curve it is possible to predict the hardness and microstructure regardless of whether the part is quenched in air, oil, water, or any other selected hardening medium.

Through a knowledge of the reaction-rate curve it is often possible to shorten annealing cycles, thus reducing heat-treating costs. Machining costs may also be favorably affected by knowing the reaction-rate curve of the steel and using it to outline a heat-treating cycle which will produce the structure found by previous experience to develop maximum machinability.

As more data become available on different steels, it will also be possible to trace the effect of such variables as analysis, grain size, heat-treatment prior to quenching, fabrication, banding, and the like. A knowledge of these factors will assist in specifying steel for specific applications where certain machining and hardening characteristics are required.

To summarize the discussion on the temperature versus isothermal-reaction-rate curves it might be stated:

1 A knowledge of the isothermal-reaction-rate curves for steel aids in the specification of annealing, normalizing, and hardening treatments by indicating the temperature of maximum transformation rate and the character of the transformation products.

2 Molybdenum and combinations of molybdenum with nickel and chromium shift the upper portion of the reaction-rate curve in the direction of increasing time, thereby decreasing the critical quenching rate and increasing the section size that can be fully hardened.

3 The seemingly mild effect of molybdenum—at least up to 0.80 per cent—on the time required for initiation of austenite decomposition below 800 F but above about 400 F in low- and medium-carbon steels suggests that molybdenum steels, besides having deep-hardening properties, will tend to transform at temperatures of 400 F or above and develop structures of the acicular type which possess greater toughness than those structures which result from austenite decomposition at lower temperatures. In other words, molybdenum assists in producing a structure in low- and medium-carbon steel by normal heat-treating processes which results only from the austempering of high-carbon unalloyed steels.

4 Alloying elements in general have little effect on the

maximum hardness obtainable in a steel of a given carbon content provided the cooling rate is in excess of the critical cooling rate in all cases.

5 The maximum hardness obtainable by quenching is primarily a function of the carbon content of the steel.

The selection of a pearlitic steel for a particular engineering application might involve the following considerations based on knowledge of isothermal transformations:

(*a*) A knowledge of the cooling rate of the part in the particular quenching medium selected—air, oil, water, brine, salt bath, or lead bath—would be helpful.

(*b*) The steel should contain the lowest carbon content that will give the required hardness.

(*c*) Incorporate such alloying element or elements as will shift the upper portion of the reaction-rate curve to the right sufficiently to permit the part to be cooled past the nose of the curve without the initiation of austenite transformation.

(*d*) If a high carbon content is necessary to give the required hardness, austempering or time-quenching treatments should be employed. Assuming a low- or medium-carbon steel will give the necessary hardness, then it is probable that the transformation will be sufficiently rapid at temperatures of 400 F or above to cause the austenite to break down into those products which are known to possess outstanding toughness.

In using the reaction-rate-curve it must be borne in mind that such factors as the grain size of the steel and the temperature to which the steel is heated before quenching have a great influence on the position of the curve in relation to the time axis. A discussion of these factors is beyond the scope of this paper.

A rapid survey of molybdenum-containing irons and steels that are employed by industry has been presented. An attempt has been made to incorporate information on the effect of molybdenum in these ferrous alloys and at the same time discuss some of the common types of molybdenum steels that are interesting to engineers. It is hoped that some thoughts have been expressed which will assist in a better understanding of these materials.

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11 "Hardenability of Molybdenum S.A.E. Steels," by R. M. Parke and A. J. Herzig, *Metals and Alloys*, vol. 11, January, 1940, p. 6.

12 "Functions of the Alloying Elements in Steel," by E. C. Bain, American Society for Metals, 1939.

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Market Analysis From Management Standpoint

(*Continued from page 792*)

In making a market analysis of a new or proposed product, management is interested in learning first what the profit will be and how long a period must elapse before the volume of sales will be sufficient, not only to pay for all the expenses of development and introduction, but also to yield dividends to the stockholders.

Inventors, salesmen, sales engineers, and some sales managers are apt to be overoptimistic and overenthusiastic concerning a child of their brain or the suggestion of a favored customer. Management, on the other hand, must be very cold-blooded and look at the project only from the standpoint of dollars and cents. A single example of the possible pitfalls that may exist in a new product, unless management is alert, is the following:

A certain sales manager suggested a product that, although it was partially a redesign of an existing machine, yet represented an entirely new product. From an engineering and an operating standpoint it was almost ideal. The proposition was presented to management complete in every detail except one. Cost of development, cost of manufacture, price at which it could be sold, cost of selling, and net profit per machine were all exhibited. It made a beautiful picture until a hard-boiled management asked the question, "What is the total market for this machine after it is developed and put on sale?" The answer to that question, multiplied by the net expected profit per machine, showed that it would barely be possible to recover the development and the experimental expenses involved. In other words, the concern would simply be developing this beautiful idea for the fun that it would get out of it. Needless to say, the idea was promptly shelved.

It is not within the province of this paper to outline the methods that should be followed in making a market analysis for a new product. There are men who have devoted their lives to this subject and are expert at it. However, after their results are in, management has to ask itself a few questions, such as the following:

Out of the total market available, what proportion can we expect to sell each year for the first five years?

What will be the cost of developing this product, including design, experiment, production of the first few lots of product, and the possibility of scrapping several lots before a satisfactory manufacturing procedure will be found?

What promotional methods must be used?

How many salesmen must be employed to achieve the distribution that is desirable?

How much must be spent for advertising?

How permanent is the market?

How strong or how weak is the patent situation?

What will be the unit cost of manufacturing this product in lots of 1, 10, 50, 100, or 10,000?

And above all, what is the net profit for each unit of sale and for the total volume of sales in a given period?

Having obtained satisfactory answers to these questions, then management is in position to know whether or not it should invest in a new product. Until it has satisfactory answers it is playing with dynamite to attempt new products.

The budget and market analysis are twin tools of good management. No business can be considered progressive that does not use them both.

COOPERATION—A CONCRETE EXAMPLE

By D. L. BRECHNER[1]

THE telephone rang. A voice at the far end of the wire said, "This is the Denver office library of the United States Department of the Interior, Bureau of Reclamation. May we please borrow *Revue Générale de l'Hydraulique* for July-August, 1939?" The Science and Engineering Department of the Denver Public Library replied that they would be pleased to send it by the Bureau messenger when he came on his regular daily trip. Similar arrangements have become commonplace in the daily routine of the two libraries and they mark the existence of a well-organized cooperative project in which these institutions have participated since 1935.

The Denver Public Library is the largest general library in the Rocky Mountain region. The science and engineering department, with which we are particularly concerned, has a collection of over 29,000 volumes, and receives regularly some 400 serials.

The Denver office library of the Bureau of Reclamation was organized in 1932, following the sharp increase in staff made necessary by a rapidly expanding program of public works. Its principal holdings consist of 1800 text and reference volumes and approximately 55,000 items in its technical data files. Its serial list includes 40 titles. This library serves a staff of about 600 engineers who are engaged in the design and investigational work of the Bureau of Reclamation.

In 1934 a group of engineers in the Bureau was discussing the scarcity of technical magazines of foreign publication available in local libraries. Various proposals for rectifying the deficiency were discussed, and among them was a proposition to investigate the possibility of initiating a cooperative project with the Denver Public Library. As this idea seemed the most feasible, a committee was appointed to meet the public-library officials in order to explore the possibility of forming a mutual-assistance pact to provide the desired periodicals. The suggestion, as presented by the committee, was enthusiastically received. After several conferences an agreement was reached providing for the joint purchase of 15 foreign technical magazines not available at that time in Denver. This serial list has since been expanded until it includes a total of 35 periodicals.

As originally planned, the funds for this purpose, provided by the Denver Public Library, were matched by private subscriptions from the group of interested engineers in the Bureau, and that arrangement has been continued.

The magazines, when they arrive at the Denver Public Library, are sent to the Bureau library where they are routed through the subscribers for examination and study. After being circulated, the magazines are returned to the public library where they are bound at the latter's expense, and thereafter become a part of their permanent collection. As the cost of this scheme is shared equally, it provides for a larger selection of specialized magazines than would be possible for either group to buy if working alone.

This project makes it possible for the subscribers in the Bureau to keep abreast of the outstanding engineering advances being made throughout the world; and for the Denver Public Library, it adds each year more than 50 valuable volumes to its reference collection.

An almost universal rule in public libraries is that their reference material is not available for circulation. However, to enable the Bureau subscribers to share equitably in the use of the magazines which they help to buy, the Denver Public Library makes an exception to their "not for circulation" rule. On request of the Bureau library, the Denver Public Library permits these particular volumes to circulate back to the engineers in the Bureau organization. As there was no known precedent by which this scheme could operate, the regulations covering it were evolved over a period of two years, after which only occasional minor changes have been necessary.

The almost immediate success of the plan quickly led to further cooperation between the two libraries. With but few exceptions, the entire reference collection of the Denver Public Library was made available to the Bureau of Reclamation library for loan periods of from one to four days. The Bureau library maintains a daily messenger service to transport the borrowed material, which during the fiscal year 1939-1940 amounted to more than 500 loans. In return, the Bureau library deposits in the public library several outstanding foreign publications of both general and specialized appeal. One of these is a particularly important engineering-society journal which is not open to acquisition by the Denver Public Library as a public library.

By authority of the Washington, D. C., office of the United States Department of the Interior, Bureau of Reclamation, there have been deposited in the Denver Public Library two 50-volume sets of historical scientific source material, and 200 bound volumes of government bulletins on Western irrigation and agriculture. In addition, the public library is made a depository for a set of Technical Memoranda, which are published by the Bureau primarily for the use of its own staff. The latter set consists of nearly 600 memoranda which, on the basis of price, is valued at approximately $1000. Additions are being made at the rate of about 25 memoranda per year. These are available to the engineering profession in general through the interlibrary loan service of the Denver Public Library.

A great deal of additional library research is carried on by the libraries in behalf of each other. The requests for information made by the Bureau library are on subjects as diverse as are the technical interests of a large engineering organization, while those by the Denver Public Library are ordinarily confined to problems involving the specialized fields of engineering in which the Bureau library has extraordinary collections of data.

Malcolm G. Wyer, librarian, Denver Public Library, in commenting on this enterprise, said, "We find this cordial relationship a most satisfactory arrangement. The patrons of the public library profit from the technical magazines and other material which would not be available except for this cooperation from the Bureau library and scientists. Our library staff also take great pleasure in the connection they have, through the reference work they do, with the important engineering projects planned in the Bureau offices. And our library knows it can always call on the research staff of the Bureau for highly specialized information on a wide range of engineering subjects."

The interest of librarians in cooperation between the institutions for which they work is manifest in the frequent appearance of articles and letters on the subject appearing in publications of interest to the profession. The achievement of successful cooperation between libraries is believed to depend chiefly on the meticulous observance of the regulations under which the cooperative scheme is carried out, and in the fact that the project must be *equitable* and *mutually* advantageous.

[1] Library Staff member of the Denver, Colorado, office of the United States Department of the Interior, Bureau of Reclamation.

MODERN OBJECTIVES *in* STEAM-LOCOMOTIVE DESIGN

By R. M. OSTERMANN

VICE-PRESIDENT, THE SUPERHEATER COMPANY, CHICAGO, ILL.

THE increasing competition which new forms of transportation are offering to the railroads makes it, in the author's opinion, incumbent upon those responsible for steam-locomotive design and production to analyze the situation and to seek avenues of departure from old established locomotive design practices which will allow realization of the utmost thermal and mechanical advantages from the use of steam in train haulage.

The development of other types of locomotives in recent years has created a problem for railroad operators and their mechanical advisers. The problem will, no doubt, be solved, and future locomotive construction will undoubtedly rest on the basis of economic analysis, after years of experience with the various available types of locomotives, i.e., after sufficient statistical data have been gathered relative to the over-all operating and maintenance cost which they produce in transportation services. Consideration of the fuel resources of the country are, in the author's opinion, bound to be also a strong factor in the selection of the type of locomotive to be used on American roads.

The possibilities of increasing the thermal efficiency at the drawbar of the steam-driven locomotive, firable by coal or fuel oil, have by no means been exhausted. It is the aim of building steam locomotives with a higher thermal efficiency which constitutes one of the objectives which the author desires to discuss further on in more detail, emphasizing at this juncture, however, that outstanding results in that direction can only be obtained with a complete departure from present designs of boilers, of steam-propulsion means, and of other parts of the locomotive. As will also be claimed by the author, other desirable objectives in design may well be reached incidentally with such radical departures from present steam practice, referring to mechanical features by which the steam-propelled locomotive of the future can be endowed with many improved characteristics which modern transportation demands require. It is, then, in the author's opinion, quite timely for mechanical engineers to analyze carefully the ultimate possibilities of steam as a medium for locomotive propulsion.

OBJECTIVES TO BE SOUGHT IN LOCOMOTIVE DESIGN

The author has become convinced that in order to strengthen the relative importance of the steam-drive principle, it would be desirable in the future to keep the following objectives in the design of steam locomotives in view:

1 To reduce substantially the need for roundhouse servicings and repairs, thereby increasing the availability of steam locomotives.

2 To decrease the cost of fuel and water.

3 To arrange to carry a larger percentage of the total locomotive weight on driving axles so as to provide enough adhesion for the large torques required in quickly starting and accelerating trains.

4 To increase the steam locomotive's operating radius with a given fuel and water supply.

5 To lower the center of gravity of the locomotive so as to make it suitable for higher speeds on curves.

6 To reduce track stresses by lowering or eliminating altogether the dynamic augment of axle loads.

7 To obtain as many of the foregoing advantages as possible without an undue increase in the weight of the locomotive per horsepower, of its length, its cost, and the maintenance expense.

The author believes that there are no insurmountable difficulties in the way of reaching these objectives, and he wishes to develop his reasons for that statement in greater detail as follows:

As to thermal gains, it is clear that by generating steam at a sufficiently high pressure, and by superheating it to the highest practical degree, a great increase in economy can be obtained. In expanding such steam to the now customary exhaust pressures, the steam rate per horsepower-hour of a 200-psi superheated engine can be reduced by 50 per cent without exceeding boiler pressures which have been successfully used elsewhere. Furthermore, it is quite safe to assume that with a complete revision of the locomotive boiler plant, with proper firing control and with fine pulverization of coal or adequate atomization of heavy oils, fuels can be burned with a far greater furnace efficiency than is possible with the present steam-locomotive firing method. The combined boiler and furnace efficiency of a hard-working coal-fired locomotive is scarcely higher than 60 per cent, while with properly controlled furnaces efficiencies of 80 per cent are on the other hand obtainable, even with high heat releases. Thus it is quite conceivable that with the mentioned increases of heat drop, and with refinements in the combustion of fuel, the resulting fuel saving per indicated horsepower-hour might reach 60 to 70 per cent.

Single-expansion reciprocating engines cannot, even with the most advanced types of steam distribution gears, cope with expansion ratios which would insure a gain of 50 per cent in adiabatic heat drop. If the diameter of the cylinders were large enough, and if cutoffs were small enough to permit adequately large expansion ratios, insurmountable starting and balancing problems would arise, not to speak of the impossibility of lubricating the valves and cylinders with the very much higher pressures and temperatures. There is, in fact, only one type of steam-expansion machine which is practical for as large adiabatic heat drops as are required for lowest steam rates, and that is the steam turbine. The torque of the steam turbine is readily adjustable and absolutely uniform, like that of an electric motor. High operating speeds and small weight per horsepower may be readily combined with reliability of operation under conditions of its operation with ultrahigh steam pressures and temperatures. The only objectionable characteristic of the steam turbine which has prevented its being directly coupled with the variable-speed drive shaft of a locomotive or other traction machine is the extravagant steam consumption when the turbine is operated at speeds other than

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that for which it is designed. The turbine is inherently a constant-speed machine and would be too wasteful of steam when coupled directly to the driving wheels of a locomotive and operated at a constant steam pressure over such wide ranges of speed as may be encountered in locomotive practice. While compromise designs of turbine buckets have been perfected with which it is possible to maintain a reasonably constant steam rate over a fairly wide range of speeds, with a sacrifice of highest possible bucket efficiency at the best rotative speed, it will still, in the author's opinion, be desirable to make special provisions against an unduly high steam consumption of such turbines in starting a locomotive and during sustained runs at unusually low speeds such as may occur on long upward grades. The author sees the necessity for more thought in the direction of furthering the practical chances of a direct steam-turbine drive, because he believes that the best combination must be one which is usable with any operating requirements, and in the interest of a far-reaching locomotive standardization.

In order to be able to sustain increased power outputs in the lower speed range of a locomotive, one must, of necessity, provide enough weight on drivers so as to be able to prevent their slipping with substantially increased torques. Propulsion means, like the electric motor or the steam turbine, that have a constant torque, greatly help to lower the factor of adhesion, but at the same time it is believed that it will be difficult to get the greatest concentration of weight on the drivers combined with a low center of gravity and with good articulation, except by designing steam locomotives which are carried on swivel trucks.

POWER TRANSMISSION TO SWIVEL TRUCKS INDICATED

When such a view is accepted, one encounters, as a result thereof, the problem of power transmission to the axles of swivel trucks. The General Electric Company chose a standard electrical transmission as the solution of this problem, in the design of the high-pressure condensing steam locomotive which had trials on the Union Pacific Railroad. Hydraulic variable-speed drives have been proposed, but as yet have not been tried for powerful locomotives. Eventually, the best solution of this problem will naturally be one which allows transmission to each available driving axle of a swiveling truck of the largest possible amount of horsepower in a simple and efficient manner.

The use of electrically driven swivel trucks invites distinctly bothersome limitations in the amount of power which can be transmitted per axle and which cannot be exceeded because the horsepower of the electric motor small enough to fit between the wheels of an axle and light enough to keep the unsprung axle load within reason is limited. Also the gyratory effect of the motor armature needs consideration. If it is too great, it has the tendency to load the springs of an axle unequally when the truck swivels, and thus leads to disturbances in running. The horsepower rating of nose-suspended motors—and such have only been used on swivel trucks—thus seldom exceeds 400 to 500 hp; whereas, if this limitation could be removed, a much larger power could conceivably be transmitted to a fast-running axle without exceeding the adhesion limit. It is well to keep this in mind when planning departures from the standard electric drive. Especially if a lighter and less bulky steam power plant were available, it would be possible to carry it on a lesser number of axles—perhaps one hundred per cent of it on driving axles—and, if so, the entire locomotive might be conceivably shortened.

As an illustration, may it be assumed that a locomotive with a weight of 400,000 lb on its drivers, with a uniform torque drive, and with a factor of adhesion of 3.5, produces a maximum drawbar pull of 115,000 lb. May it also be assumed that this locomotive has a boiler large enough to develop about 6000 hp at 80 mph. If a locomotive weighing not more than 66.8 lb per hp were possible, the entire weight could be carried on eight driving axles with, say, 44-in. wheels, and on two swivel trucks, also provided that 750 hp could be safely transmitted to each of these axles. The ideal drive arrangement, the author believes, would be one by which a high-speed turbine of small weight was directly coupled to three or four small-wheeled driving axles of a swivel truck, and in which the turbine could be compounded at starting and in the lower speed range with some sort of a directly coupled auxiliary engine. A practical reduction-gearing arrangement for connecting the turbine shaft to the axles of swiveling trucks would have to be perfected, which should be quite feasible mechanically. Then, a wheel arrangement would result such as is shown in Fig. 1. Such a locomotive might have a maximum drawbar pull of about 115,000 lb, and it might be built for various maximum horsepower outputs. The weight per horsepower of the locomotive as a whole will govern the number of carrying axles which have to be provided between the drive trucks; the building length will depend upon the size of the boiler plant, of the auxiliaries, of the fuel and water storage tanks, and will determine whether or not the locomotive requires an articulated joint in the center of its frame.

BOILERS AND THEIR CONTROLS—CONDENSERS

The water-supply problem and its cost for steam locomotives is too well known to warrant a detailed discussion here. It might be only restated what C. A. Brandt pointed out in his recent paper on the locomotive boiler,[1] that the water problem constitutes, on many railroads, the most serious output limitation of the present locomotive boiler. It is safe to predict that the now-existing carry-over troubles would be materially aggravated by the use of such higher pressures as would be required in order to obtain the necessary increase of the thermal efficiency. This circumstance in itself would nullify all attempts to build conventional locomotive boilers for pressures materially higher than are now used, on the part of those railroads that have to use softened waters. Actually, water-tube

[1] "The Locomotive Boiler," by C. A. Brandt, Trans. A.S.M.E., vol. 62, 1940, pp. 379–419.

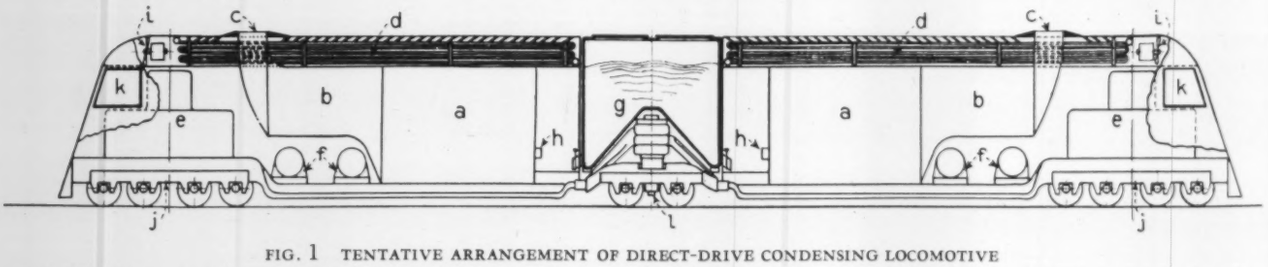

FIG. 1 TENTATIVE ARRANGEMENT OF DIRECT-DRIVE CONDENSING LOCOMOTIVE

(*a*, boiler; *b*, water storage; *c*, stack; *d*, condenser; *e*, turbine engine; *f*, auxiliaries; *g*, fuel tank; *h*, burners; *i*, cooling fan; *j*, swivel truck; *k*, cab; *l*, carrying truck with articulated frame joint.)

boilers only would be light enough, but regardless of the type of boiler which would be selected for the generation of steam at a superpressure, relatively pure feedwater must be used for trouble-free service. From the recognition of this fact, there should follow another valuable objective for steam-locomotive designers, and that is the development of practical exhaust-steam condensing means, for the sole purpose of providing pure feedwater.

The main difficulty which has opposed itself to the use of steam condensation on locomotives has been the size, weight, and power requirement of the condenser. Air is the only medium for carrying off the heat which must be dissipated in the process, and the heat-transfer factor is only of the order of 12 to 14 Btu per sq ft per deg temperature difference per hr, even at considerable air velocities and with appreciable power outputs for the cooling fans. Reckoning with maximum air temperatures of 120 F, as one must do in this country in summer, the surfaces required for condensation at low absolute pressures are prohibitive on locomotives, both as to weight and size of the condenser. The author, nevertheless, urges further studies of locomotive condensers by American engineers, believing as he does that a practical solution of the condenser problem is vital for demonstrating the best there is in steam for locomotive propulsion.

Let it be again clearly stated how one requirement of the most desirable steam locomotive leads to others:

1 Minimum fuel cost demands ultrahigh boiler pressures and steam temperatures.

2 Ultrahigh pressures demand water-tube boilers for reasons of weight.

3 Water-tube boilers operated with ultrahigh pressures demand pure feedwater.

4 Pure feedwater demands condensation on the majority of American railroads and promises to all railroads freedom from frequent waterstops, boiler washings, and boiler repairs.

The search for the lightest, most rugged, and most easily installed condensing means should be undertaken, not with the thought of obtaining more horsepower by expansion of steam below atmospheric pressures, but of utilizing the largest possible adiabatic heat drop in the turbine over and above a condensation heat level which is itself high enough to make possible an air-cooled condenser of reasonable weight and proportions. Raising the heat level of condensation, true enough, means the dissipation of more heat units per horsepower-hour and less power of the main turbine, but it also means less power on the condenser fans, and these may require as much as 25 per cent of the total generated power. High availability is, in the view of many observers, relatively more important than fuel cost. The author shares this view and therefore does not hesitate to urge condensation, even if it might mean an increase in the fuel consumption of the locomotive. Relative fuel costs alone, which are likely to be upset by extraneous circumstances, would, anyhow, not alone decide the fate of a locomotive's design, but only in conjunction with other factors which influence the total operating cost.

AUTOMATIC-FIRING AND BOILER-FEED CONTROLS

Another serious design problem which results from the high-steam-pressure objective and which has to be solved in a simple and foolproof manner, is that of automatic-firing and boiler-feed controls. For the very high pressures which, as has been stated are essential, only boilers are light enough which consist of tubes, and which have of necessity a very small heat-storage capacity. Such boilers are very sensitive to quick load changes that occur often in locomotive operation; if the burners were controlled from boiler pressure, it would be practically impossible for the burner operating mechanism to follow the pressure fluctuations quickly enough. The same is true of boiler feeding mechanisms, especially in the absence of fair-sized drums and relatively fixed water levels. A considerable study of this problem will have to be made, and it will challenge the designer's ingenuity. Hand-firing of either coal or oil, as well as overfeed-stoker-firing of coal, does not seem to be at all practical with a condensing locomotive, because the locomotive should always be so fired that there is no loss of steam through the boiler safety valves in order that such a loss may not interfere with the conservation of the water supply. Hence the firing must be automatic, and the heat supply must be adjusted in some way to the boiler's steam demand without undue lag.

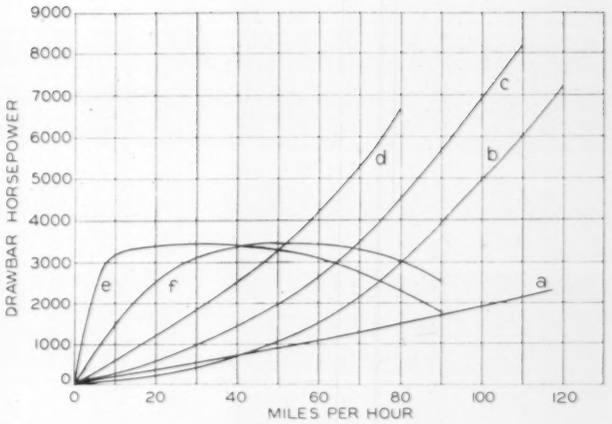

FIG. 2 DRAWBAR-HORSEPOWER REQUIREMENTS OF TRAIN WEIGHING 1000 TONS INCLUDING LOCOMOTIVE AND DRAWBAR-HORSEPOWER OUTPUT OF NOW AVAILABLE PASSENGER-TRAIN LOCOMOTIVES

[(*a*, Drawbar horsepower required for acceleration of train including locomotive (10 mph per min); *b*, drawbar horsepower required for train and locomotive resistance (formula of F. J. Cole); *c*, total drawbar horsepower required on straight level track; *d*, total drawbar horsepower required on $\frac{1}{2}$ per cent grade; *e*, drawbar horsepower of 5400-hp Diesel-electric locomotive (report of I.R.F.A.); *f*, drawbar horsepower of 4500-ihp, 4-6-4 steam locomotive (report of I.R.F.A.).]

With a properly controlled fuel and air supply, and with the help of a properly maintained furnace pressure, the emission of smoke can be greatly curtailed. In the case of firing with powdered coal, fly ash would be undoubtedly emitted through the stack, but it is believed that the dirt and inconvenience arising from it would never be as disturbing as the steam, smoke, and cinders of present stoker-fired locomotives. The elimination of the atmospheric exhaust would, of course, cause a very much quieter operation of such an improved steam locomotive.

CONCLUSION

In conclusion, the author expresses the hope that by his frank advocacy of such radical departures from conventional steam-locomotive design as are implied by his "modern objectives," he has not exposed himself to criticism by the more conservative who can justly claim much merit for fine engineering work done in the perfection of the "iron horse," for this sketchy and rambling paper, and for the absence of more definite design information. The author has no illusions about the size of the task which has to be done before his objectives are reached. What he is interested in at this time is to present a basis for thought and discussion. It remains his hope to contribute something more substantial at a later date.

At present, prospects are mainly still obscured by the uncertainty of the best condenser design and of the weight and general arrangement of the condenser; the best method of

adapting a steam turbine to the direct axle drive also needs much clarification. Whenever a satisfactory solution for these problems is found, the operating characteristics of the novel steam locomotive referred to can be far more easily visualized. The aim of research and development in this field appears to be a most tempting one, for it may be regarded as quite likely that whenever a steam turbine with a direct drive can be combined with an automatically fired, forced-circulation, water-tube boiler and with a condenser that is not too heavy, a combination will result which will not only decrease the total operating cost of steam locomotives appreciably, but will also, without undue weight increase of locomotives, provide the large power outputs and sustained torques desirable in high-speed operation of heavy trains. In a condensing steam locomotive, the draft, the evaporation, and the superheat would not have to be functions of the amount of exhaust steam and its pressure, as in present reciprocating locomotives, but could be regulated at will by the rate of firing, at any locomotive speed, so as to satisfy whatever the requirements of the driving turbine plus auxiliaries might be, provided, of course, that the maximum boiler capacity were not exceeded, and provided further that the condenser were able to condense all the steam exhausted by the driving turbine and the auxiliaries.

Some time ago, the Association of American Railroads published a report of tests during which an endeavor was made to operate a 1000-ton train at 100 mph. The report reveals how much power is required in order to accelerate a train of such weight at such high speeds over a reasonable length of track. The curves of Fig. 2 present the same facts in a different form. Calculated curves of total train resistance on level track and on a $\frac{1}{2}$ per cent grade are given as a function of speed, and the calculated horsepower required for accelerating the train at the rate of 10 mph per min was added, resulting in the total horsepower requirement. In contrast to these totals, drawbar-horsepower curves of a 4500-ihp Hudson type steam locomotive, weighing with the tender 222 lb per maximum drawbar horsepower, and of a 5400 nominal hp Diesel-electric locomotive, weighing 255 lb per maximum drawbar horsepower, are presented in Fig. 2. The latter two curves were taken from a report of the turbine locomotive committee of the International Railway Fuel Association and set forth the inadequacy of present passenger locomotives at the higher train speeds which the railroads are seeking.

Full acknowledgment should here be made of the far-seeing work which the aforementioned committee has done in trying to advance the cause of steam in locomotive propulsion. The committee has revealed in its reports that it is fully conscious of the necessity to reduce the weight of a steam locomotive per maximum drawbar horsepower by all practical mechanical means and to depart from old traditions in order to concentrate as much of that weight as possible on the drivers. It has also been conscious of the necessity to decrease the steam rate of such locomotives relative to the drawbar, all possible by increasing the heat drop through the propulsion means and by avoiding undue power-transmission losses, in order to produce maximum drawbar horsepower for a given boiler weight and maximum evaporation capacity.

The author's stated objectives relating to high thermal efficiency, direct drive, and largest possible weight concentration on drivers fully check with the I.R.F.A. committee's ideas.

Cushing

CITY HALL AND THE MUNICIPAL BUILDING IN NEW YORK CITY

(Viewed from across City Hall Park. For the complete technical program and details concerning trips, excursions, and social events scheduled for the 1940 Annual Meeting of The American Society of Mechanical Engineers to be held in New York City, Dec. 2–6, see pages 847–854 of this issue.)

The Treatment of TEXTILE WASTES

By HAROLD B. GOTAAS

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BECAUSE of the variation in quantities and types of wastes discharged by different mills, the problems encountered in textile-waste treatment are numerous and complicated. No attempt is made in this paper to discuss the technical details of textile-waste purification. Instead, general information which may be helpful in approaching the solution of local textile-waste problems is presented.

Water pollution by industrial wastes followed closely the industrial expansion and population growth of the last fifty years, and relatively recently has become an important national problem. With this continued growth and expansion have come new and varied uses for natural water courses. Several of the purposes for which a stream may be used legitimately are: Domestic and industrial water supply; domestic sewage disposal; industrial waste disposal; irrigation; development of power; recreation; shellfish and commercial fishing industries; habitat for wild fowl; and navigation. Obviously, several of these uses conflict. Hence, there is a definite economic limit to the extent to which a stream can be used for any one purpose without curtailing its use for other purposes. This limit depends upon the character of the stream and the other purposes for which the stream is used.

When considering stream pollution, we should not limit attention to public health, public decency, recreation, and wild life conservation, but also should consider its important economic aspects. Several industries, especially the textile industry, have recognized the present and potential future damage to their processes and plants due to the pollution of streams by themselves, other industries, and municipalities. Industries, such as the textile industry, which require a water having a high degree of purity and clarity for modern processes, in many cases, are finding that it is difficult and sometimes almost impossible to maintain an acceptable quality of water because of the pollution upstream from their source of water supply. The additional cost for plants and chemicals necessary to treat a polluted water is a large economic loss to industry and the public alike. Other economic effects of stream pollution are the destruction of stream life, damage to structures along the stream, and the creation of public nuisances which depreciate property values near the stream.

POLLUTIONAL CHARACTERISTICS OF TEXTILE WASTES

Textile wastes vary widely in their pollutional properties. No attempt will be made in this paper to list the chemical and physical characteristics of each of the many textile wastes. It is sufficient to summarize the general effects produced by the various wastes on the receiving stream.

Oxygen Depletion in the Stream Water. All textile wastes contain quantities of unstable organic material which, under the normal processes of stream self-purification, serve as food for the biological life in the stream. As this material is decomposed and stabilized the oxygen resources of the stream are drawn upon. If the demand for oxygen is so great as to exhaust the oxygen supply of the stream, septic conditions arise accompanied by bubbling gases, obnoxious odors, and an unsightly black appearance. Ample dissolved oxygen is essential for the maintenance of fish as well as other biological life in the stream.

The wastes from the deterging processes of the textile industry usually exert a larger biochemical oxygen demand on the oxygen resources of the stream than any other textile waste, because of the large amount of readily decomposable organic matter present. Moreover, dye wastes containing strong chemical reducing agents may exert a chemical demand on the oxygen resources equivalent to a high biochemical oxygen demand.

Toxicity to Stream Life. Some textile-processing wastes contain chemicals which are toxic to fish as well as to the bacteria and other biological life which carry on the processes of stream self-purification. Strong alkaline or acid wastes alter the character of the stream to such an extent that biological life cannot be maintained. Certain dyes are toxic to plant and animal life.

Physical Impairment to the Stream. The physical appearance of a stream brought about by textile wastes is usually not of especial hygienic importance, but it is of utmost importance to the layman and to people who are bringing pollution litigation against the industry. Most lay riparian owners as a rule attach little significance to the important matters of hygienic quality, oxygen demand, and toxicity, but instead judge the extent of pollution by color, turbidity, and the presence of odors and floating materials. Thus, the consideration of color when dealing with textile waste is important in many instances.

METHODS OF TEXTILE-WASTE TREATMENT

Quantities of Textile Wastes. The wastes from the deterging processes—wool scouring, cotton kiering, silk degumming, flax retting, and rayon wastes—not only contain more decomposable organic matter, but also are discharged in considerably larger quantities than any other type of waste. Of the dye wastes, the direct and sulphur dyes are discharged in largest quantities.

A general idea of the quantities of textile wastes discharged may be gained from a report (1)[1] of a survey made in 1930 by the North Carolina Board of Health, in which it is reported that of 459 mills in the state at that time, 147 of them discharged a total of 59,000,000 gallons of waste liquor per day. About 7,200,000 gal of this total could be classified as concentrated objectionable waste requiring treatment, the remainder being dilute wash waters.

The strong waste consisted of 4,000,000 gpd of kier liquor, 935,000 gpd of sulphur dye liquor, 865,000 gpd of direct color waste, and 1,400,000 gpd of miscellaneous wastes. The oxy-

Contributed by the Textile Division for presentation at the Annual Meeting, New York, N. Y., Dec. 2–6, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] Numbers in parentheses refer to Bibliography at end of paper.

gen demand of these wastes is probably equivalent to that of the domestic sewage of 150,000 people.

Out of litigation over conflicting interests in the use of streams, public interest in wild life, stream purity, and conservation, and the economic interest of industries hampered by the pollution from other industries as well as from their own, have been born the problems of waste treatment.

Textile-waste treatment is one of the most complex problems in the field of industrial-waste treatment because seldom are two textile wastes alike in character, therefore, they may require quite different treatment processes. The composite wastes from each mill differ, and because of changes in the market demands and the manufacturing processes, the wastes from any one will change frequently.

Although some textile wastes were treated in this country and abroad, little was accomplished prior to 1925, and most of the information concerning textile-waste treatment has been developed since 1930. Prior to 1930 several mills in regions where stream pollution was most severe built waste-treatment plants at large costs. Many of these plants did not provide remedial treatment commensurate with their cost because of the lack of scientific information on the subject.

In 1932 the Textile Foundation, cognizant of the imminence of the waste and stream-pollution problem, and of the probability that millions of dollars might have to be spent for building textile-waste-treatment plants before basic information on the fundamental problems of treating wastes should become available, established a textile-waste research program in cooperation with the University of North Carolina. This project has been carried on under the direction of an advisory committee and the direct counsel of H. G. Baity, department of sanitary engineering, University of North Carolina.

A survey (9) of available literature on textile-waste treatment and disposal was made by J. C. Geyer and W. A. Perry and published by the Textile Foundation in 1936.

Investigative work has been carried on in an endeavor to develop general principles and procedures, basic in character, which can be used and further developed by the industry in solving specific waste-disposal problems. Because textile-waste problems differ at each mill, no attempt has been made to solve any one situation, but instead to produce general and basic information useful to the industry at large. Several reports have been published and others will be published in the near future.[2]

Treatment of Textile Wastes With Domestic Sewage. Biological processes are the most logical and have proved to be the most economical methods for purifying domestic sewage. Where it is possible to use a biological process, it will usually prove to be most economical for textile-waste treatment. Textile wastes may be satisfactorily treated in conjunction with domestic sewage by a biological process, but several factors must be carefully controlled. Of the various factors involved, the character of waste being treated is the most important. Biological processes will become acclimated to purify rather strong and difficult wastes, but they will not withstand shocks due to sudden extreme variations in the quality of the waste being treated.

When the textile wastes are discharged at will into domestic sewage, the mixture reaching the treatment plant may in a few minutes change from slightly acid sewage to a highly colored, strongly alkaline mixture containing large amounts of extremely toxic substances.

The equalization or averaging of wastes and the regulation of their discharge into the domestic sewage by the use of equalization tanks and discharge devices are the most important procedures in maintaining a relatively uniform waste at the treatment plant. A moderate strength, nontoxic waste, i.e., one that furnishes food for the bacteria and biological life without creating unsatisfactory living conditions, may be discharged uniformly throughout a twenty-four-hour day. However, toxic wastes and strong nontoxic wastes, which are most common, should be discharged in proportion to the sewage flow, thus providing a relatively constant mixture.

Although equalization and regulation of waste discharge is essential, it does not completely solve the problem if the volume ratio between textile waste and domestic sewage is such that the sewage does not neutralize the toxic properties of the waste. This condition requires the additional use of one or a combination of the following treatments preliminary to biological purification:

1 Partial preliminary chemical treatment to neutralize strongly acid or alkaline waste or to remove toxic materials.

2 Chemical precipitation of the sewage-textile-waste mixture to reduce the load on the biological process.

3 Preliminary aeration to oxidize a mixture containing large quantities of reducing chemicals or a highly septic mixture before biological treatment.

Treatment 1 should be provided at the mill or near where the textile waste is discharged into the sewage. Treatments 2 and 3 are provided at the sewage works.

Partial preliminary chemical treatment should be supervised by the sewage-works operator so that it may be correlated with the requirements of the sewage-treatment plant.

Experimental investigations and the experience of some municipal sewage-treatment plants have shown that textile-waste-sewage mixtures can be satisfactorily treated by the activated sludge or the trickling filter processes if the character of the mixture and the process are properly controlled. The activated-sludge process will remove the decomposable organic matter and the color, producing a highly purified effluent. It will not withstand the shock of sudden variations in the character of the waste, large amounts of toxic substances, or change in the pH value. The trickling filter will remove the organic material giving good purification and is much more resistant to adverse operating conditions with regard to both the character of the waste and control methods. However, the filter does not remove the color due to dyes nearly as well as does the activated-sludge process, when the normal treatment time for each process is used.

Several sewage-treatment plants which were designed to treat sewage-textile-waste mixtures are giving satisfactory results. The activated-sludge plant at Greensboro, N. C., treating sewage-textile-waste mixtures in which the composite textile waste is about 20 per cent of the sewage flow produces an excellent effluent. The mixture, which is strongly alkaline, is first neutralized with sulphuric acid and then chemically precipitated before being treated by the activated-sludge process. The Durham, N. C., sewage-treatment plant successfully treats a sewage-kier liquor mixture. The ratio of sewage to kier liquor is such that neutralization is not necessary. In each of the aforementioned plants, experimental studies were made prior to building the plant so that it was known what would be required of the plant and how the requirements could be accomplished. At Shipley, England, a trickling filter plant is handling a waste which consists of two thirds domestic sewage and one-third textile and other trade wastes. Good purification is obtained, but there is a residual color due to the dye wastes.

The treatment of textile wastes with domestic sewage pro-

[2] Reprints of the reports of the work done by The Textile Foundation may be obtained from E. T. Pickard, secretary, The Textile Foundation, Commerce Building, Washington, D. C., or from the Department of Sanitary Engineering, University of North Carolina, Chapel Hill, N. C.

vides an economical solution to the trade-waste problem. When considering this method the wastes should be classified as follows:

1 Wastes which require no treatment.
2 Wastes which may be discharged into the sewers at will.
3 Wastes which require equalization of character and regulation of discharge.
4 Wastes which require in addition some preliminary treatment.
5 Wastes which should be excluded from the sewage-treatment plant.

The classification into which a waste falls depends upon local conditions, i.e., the character of the particular waste, its volume in proportion to that of domestic sewage, the total amount of trade wastes produced in the community, and the nature of the treatment plant.

Chemical Treatment of Textile Wastes. Chemical precipitation is the most widely used and one of the most important methods for treating textile wastes separately because the local situation is often such that the waste problem falls into the foregoing classifications 4 or 5. However, chemical precipitaton is usually the most expensive method of purification.

Chemical treatment may be used partially to treat strong wastes to a condition such that the remaining treatment can be effected in conjunction with domestic sewage. If a mill is so located that it cannot make use of domestic sewage facilities, chemical precipitation alone or with subsequent secondary treatment, while usually more expensive, may be used to render the waste satisfactory for disposal into streams.

The most economical coagulant, the amount required, and the most satisfactory procedure of treatment will vary depending upon the specific waste. Hence, it is important in controlling costs and in obtaining satisfactory results that the chemical treatment be administered by men familiar with the scientific principles involved. Some coagulants are economical and satisfactory for certain wastes and not for others. For example, wastes containing large amounts of sulphur dyes should not be precipitated with acid or filter alum unless provision is made to take care of the toxic hydrogen sulphide which is released. However, iron coagulants will precipitate this waste without the release of hydrogen sulphide.

The batch method for the chemical precipitation of textile wastes is usually more economical and provides more satisfactory operation than the continuous method. Since tanks are necessary to average extreme variations in the mill waste, the waste from one tank which is a constant quantity and quality can be treated at once, eliminating many of the problems accompanying continuous treatment. Also batch treatment facilitates recovery procedures.

The cost of chemical treatment varies with the character and quantity of waste. It is often possible to effect savings by the isolation of certain wastes. The dilute wash waters can be discharged into sewers without preliminary treatment and sometimes when very dilute may be emptied directly into streams. However, if strong wash waters and concentrated wastes are mixed with dilute wastes the composite mixture will require chemical treatment. It is often much less expensive to treat a small volume of concentrated waste at a high unit cost than to treat a large volume of weaker waste at a low unit cost. Isolation of certain wastes facilitates the use of practices which will reduce the quantity of waste and make possible the recovery of by-products.

REDUCTION OF WASTE AND RECOVERY OF BY-PRODUCTS

The practicability of reducing the amount of waste within the factory and of recovering by-products should be carefully investigated prior to adopting treatment methods and constructing treatment works. The possibilities for reducing both production costs and waste-treatment costs by reduction, reclamation, and recovery are far from being exhausted; in fact, such opportunities for lowering costs are many.

Liquid wastes are often considered as materials to be discharged and forgotten; however, a sounder point of view is to consider anything produced by the factory as a product of that process; thus, the waste from the dyehouse or the kiers is as much a product of the factory as the finished cloth. Just as an effort is made toward increasing the quality and quantity of salable goods, an effort should be made to reduce the quantity of waste products. A textile mill in Pennsylvania reduced the volume of its waste by more than 50 per cent without detriment to the processes or to the goods produced.

Reduction of Liquid Wastes. Reduction in the amount of liquid wastes may be effected by re-using certain waste liquors from one operation to make the bath for another, by more completely exhausting strong processing solutions, and by re-using certain wastes after settling and filtering.

An example of waste reduction is supplied by a mill which had been discharging strong caustic boil-out liquors. The mill followed a suggestion that this material be used in the kiers, which use a weaker caustic solution than the boil-out liquor, and be more completely exhausted. This procedure has saved the mill a considerable amount in the cost of caustic as well as saving in the cost of chemicals necessary to neutralize and purify this strong waste. This mill is now considering methods of still further reducing the quantities of other materials which not only are being wasted but also require expensive treatment before being discharged into streams.

Considerable reduction in amounts of wastes can be achieved by using counterflow action and modern equipment.

Many mills pay little attention to the amount of wash water used, with the result that often much more is used than is needed. Water purified to the degree required by the textile industry is relatively expensive and control of its use will not only reduce the volume of waste to be treated but lower the cost of water.

Recovery of By-Products. Except for a few materials, recovery of by-products in the textile industry has not been economical when the quantity of wastes was kept at a minimum in the mill and when no treatment before discharging was necessary. However, when waste treatment is necessary, recovery of by-products will often appreciably reduce the cost of treating the waste. This is especially true where certain concentrated wastes can be isolated.

Several of the dyes may be recovered and re-used with satisfactory results. Experiments conducted by the Textile Foundation have shown that sulphur and vat dyes may be readily recovered and satisfactorily re-used while direct dyes offer little possibility for recovery.

The precipitated sludge from chemically coagulated vat or sulphur dye wastes may be treated with acid to dissolve the chemical coagulant from the dye. Not only is the remaining dye satisfactory for re-use but the effluent containing the dissolved chemical coagulant may be used to coagulate and precipitate more waste. Laboratory experiments have shown that almost all of the dye in the waste and from 55 to 95 per cent of the coagulant can be recovered. Studies on indigo wastes show that the indigo and the zinc may be recovered; however, in modern indigo dyeing processes the only waste dye is a small amount in the wash waters.

Recovery of caustic soda from textile waste has proved to be economical in a number of textile mills. At the present time dialysis and centrifuging and evaporation are the best methods.

In the purification of wool-scouring wastes, the first essen-

tial step is the removal of the grease. Several methods which embody recovery of the grease have been developed and are now being widely used in the industry. Tin and tin salts may be recovered in the treatment of silk-weighting waste waters.

Though little work has been done on the recovery of kier and bleach wastes, they offer excellent possibilities for economical recovery. Research on the recovery of these wastes is greatly needed and would no doubt be an economical venture for many textile industries.

Waste heat and waste steam, while not important from the aspect of stream pollution, frequently may be recovered and economically used in the processes of reclaiming other waste materials.

No doubt many mills would find that a thorough waste and reclamation survey would contribute much toward solving their waste-disposal problem, and would also indicate where savings in processing could be made.

COOPERATION BETWEEN MUNICIPALITY AND ITS INDUSTRIES

The cooperative relationship between a city and its industries is of paramount importance in solving the waste-treatment problem. The economical and satisfactory disposal of the wastes of industries located in a municipality should be as much a concern of the city as the disposal of domestic wastes of its inhabitants. However, some cities take an extreme point of view and prohibit the use of sewers and other sewage facilities for industrial wastes, thus placing an undue burden on the industry to dispose of its wastes. A sound municipal policy in this matter is to permit the use of its waste-disposal facilities by industry on the same cost basis as they are used by the inhabitants for domestic waste disposal, i.e., each user pays the allocated portion of the total costs due to his waste. Industries having wastes which are toxic to sewage-treatment processes should through cooperation with the city undertake measures to prepare these wastes for discharging into sewers.

Usually the total cost of treating domestic sewage and industrial wastes will be less when the two are treated together than when they are treated separately. Also through cooperation it is possible to have better-qualified personnel to supervise the treatment processes. It is then to the interests of both the industries and the municipality to cooperate in the waste-treatment problem. The psychological effect resulting from the cooperation of each industry and the city on their mutual problem of waste treatment is not only beneficial to the community but to the entire region.

In many cities joint effort has effected an economical solution to the waste problem. A notable example is Greensboro, N. C., where wastes from the Cone textile interests are treated along with the domestic sewage. The industry collects in holding lagoons its composite wastes, discharges them proportionately into the sewage plant, and pays the costs of treatment which are allocatable to its specific waste contribution. By the same method of calculation, it bore its proportionate part of the capital cost of the treatment works.

RESEARCH IN TEXTILE-WASTE TREATMENT

The economic solution of textile-waste problems is dependent upon research which adds new information concerning the various aspects of textile-waste production, reclamation, and treatment. The research may be divided into two general classifications: First, basic and fundamental research which is applicable and useful in solving various types of local waste problems and, second, research for the solution of a specific waste problem. The two types of research may be integrated to provide methods for textile-waste treatment which will not only solve various local waste problems but will also lower the costs of waste treatment in general.

Various agencies, notably The Textile Foundation, the New Jersey Agricultural Experiment Station, the North Carolina Board of Health, the Massachusetts State Board of Health, the Connecticut State Water Commission, individual mills, and cities have carried on investigations which have produced information essential to the industry. Yet there is an urgent need for further research on the fundamental factors of textile-waste treatment; even more urgent is the need for research on specific waste problems.

Textile-waste-disposal problems are not of the type for which cure-all methods can be found by doing a certain amount of research or by discovering certain facts. These problems will be solved only through continued investigative study and the correlation of experiences. If there is an absolute rule which can be applied to textile-waste problems it is that individual waste problems differ and that each problem requires individual study.

On the industry itself, or the industry in cooperation with the governmental subdivision in which it is located, rests the responsibility for sponsoring studies leading to the economical solution of individual waste-disposal situations. This research will involve the study of the application of known basic information to the specific problem and the development of new information on treatment procedures and methods. As new manufacturing processes change the character of the waste, continued studies will be necessary to adapt the treatment processes.

Economic interests of the industry together with public interest in stream pollution and the stream-pollution bill now pending before the Federal Congress will no doubt expedite work on textile-waste disposal.

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RESOURCES *and* NATIONAL DEFENSE

Choices of Raw Materials and Energy Sources in Relation to the Natural Cycle

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THE present national emergency dramatizes the problem of choosing raw materials and sources of energy for the nation's industry.

In all the early history of this country's economic development, we exercised little choice. Until a generation ago, there was practically no background of research and thinking on this matter and its relation to the continuity of our civilization. In the previous emergency two decades ago, for instance, industry's requirements were met by materials closest at hand. New mines were opened and grasslands plowed up without regard to consequences. Neither engineer, farmer, nor business executive had much information on the effects upon the supply of resources for the long pull. Today, we know more about our resources, their extent and their limitations, and about our dependence upon them. In this emergency we can do some *thirty-year thinking* regarding the future security of our nation, in addition to *three-year thinking* about our immediate requirements.

What are the considerations involved in such thirty-year thinking as to choices of materials and energy sources? Are there any general principles as guideposts for the engineer and management to watch when making industrial policy decisions? While immediate considerations of cost and a thousand other difficulties will often dictate departures from the best possible policies, especially under emergency conditions, setting up such policies will define the main road to which we should return after forced deviations and detours.

TWO KINDS OF RESOURCES

Basically, we have choices between two entirely different kinds of resources. The first kind consists of the *exhaustible* resources, like minerals, stored in the earth by natural processes millions of years ago. As they are used, they dwindle in quantity and become more costly. Ultimately, supplies become exhausted. The second kind consists of *recurring* resources like agricultural and forest materials, which may be made available year after year by following proper practices. Others, like water power, can be used forever without any diminution in the supply.

The general choice of direction is that of working with nature, with man's actions being part of what might be called the natural cycle, or of working at cross-purposes to it by making excessive demands on stored resources. "Brushing aside the confusions of history, we see that one culture after another has passed away, or else made peace with itself and nature by establishing some sort of balance. The price of wrong adjustment has been the same price exacted earlier from countless kinds of extinct animals and plants—oblivion."[1]

Primitive life followed the natural cycle[2] and was permanent. In this cycle, plants were the constructive element and animal life (including man) the destructive element. Animals (including man) used up raw materials, mainly the sugars, starches, cellulose, fats, and proteins, which plants made with the help of the sun by photosynthesis from the elements carbon, hydrogen, oxygen, and nitrogen. These were used in building their bodies, the only machines then available. Energy to run these machines came from the same sources—combustion of fats, sugars, carbohydrates. Heat energy came from the combustion of wood, which is cellulose, a replaceable resource, or directly from sunlight.

But primitive man was not fundamentally destructive of resources, for he consumed recurring materials, the elements C, H, O, and N being drawn from air and water, of which there is an inexhaustible supply.

Primitive life, however, had no technology, and hence provided only low standards in terms of material things. Man's civilization with the aid of science and technology has enabled him to raise production and consumption enormously, and release human energies for cultural pursuits.

But technology has accomplished this by dangerously breaking the natural cycle. The result is that civilized man—wielding science and technology—is fast destroying the basis of civilized life. We are using irreplaceable materials too fast; we are using stored energy too fast. "For the bulk of our energy, we shamelessly sponge off the past ages."[3]

Like the encroachments of Hitlerism, the dangers of resource depletion have been continually before our eyes. We have suddenly reached a decision to protect our civilization against the former menace. When we are ready to deal effectively with the latter, the same science which has been used at times for destructive ends can be used to show us what we should do. We shall have to restrict our dependence on stored resources, but we shall learn how to harness the natural cycle with an efficiency far beyond anything which primitive man could achieve. While we may not be able to maintain our present lavish consumption of certain things, we should be able to have a high standard of living, much more secure than at present.

The following discussion of specific problems in the use of materials and energy indicates the principles to be considered

[1] "This Is Our World," by Paul B. Sears, University of Oklahoma Press, 1935.

[2] The functioning of the natural cycle and its place in supplying man with materials and energy from *recurring* sources has been a matter of lifetime concern to Dr. Harcourt A. Morgan, biologist, educator, and administrator, now Chairman of the Board of the Tennessee Valley Authority. Only a brief summary can be included in the present article of the implications of this thesis which Dr. Morgan for a generation has been presenting with great effect as a challenge to leaders in public administration and business in the South.

[3] "The Next Hundred Years—the Unfinished Business of Science," by C. C. Furnas, Reynal and Hitchcock, New York, 1936.

and the choices which have to be made. A number of the examples are chosen from activities with which the authors are associated, but other engineers will see applications in their own fields.

SOME SPECIFIC RESOURCE PROBLEMS

Power for Aluminum. One of the first problems faced by the National Defense Advisory Commission was that of getting more aluminum for expanded airplane manufacture, and sufficient electric power to produce the aluminum. Presumably, the power could have been supplied either from coal, an exhaustible source, or from water power, a recurring source. In this case the recommendation of the conservationist and that of the engineer turned out to be the same. The way chosen to get most of the power was from falling water by a new hydro plant; however, a steam plant is also to be built to permit fullest use of the water power.

Conservation in its best sense does not mean stopping the draft on our stored resources, such as coal, but making effective use of them for the long pull. The foregoing example illustrates such a compromise. Although coal will last a long time, it should also be remembered that we shall probably greatly accelerate its consumption as a raw material for making synthetic products, like nylon, alcohols, plastics, rubber, and nitrogen fertilizers. At the same time, we shall for a long time be dependent upon coal as our major source of energy.

Ores for Airplane Metals. While much of the energy for making aluminum can come from recurring sources, what about the sources of the mineral itself? The ore of this metal is bauxite, of which this country has limited supplies. Most of the bauxite used in making the nation's warplanes now comes from foreign sources, mainly from South America. Eventually, the supply will be exhausted, and conceivably in time of war these foreign deposits might be completely cut off. An alternative practically inexhaustible source might be from clay. Both the Tennessee Valley Authority and private industry have been active in development work on processes for the production of pure aluminum oxide from high alumina clays near hydro power. Before the present national emergency is over, it might well be desirable to make use of such processes.

Another metal lighter than aluminum is coming to the forefront because of the emergency. That is magnesium, which is finding increased use in alloys for airplane construction. So far in the United States this metal has been made by electrolysis of magnesium chloride from natural brines found in only a few locations. The Dow Chemical Company has recently built a new plant which it is reported will be used to obtain this element from sea water, a practically inexhaustible source. An estimate in MECHANICAL ENGINEERING for October, 1940, page 742, indicates that one cubic mile of sea water contains 5,700,000 tons of magnesium, enough to keep the new plant operating at full capacity for 800 years.

Another extensive source of magnesium, now being investigated, is the olivine deposits of the Tennessee Valley. This ore contains 20 to 30 per cent magnesium and is not now being used to any great extent. One quarter billion tons are available.

These cases illustrate the objective of drawing on the least exhaustible sources. Utilizing scrap is also important in putting metals to their fullest use, since it builds up a recurring source of supply.

Phosphorus and the Natural Cycle. This key element is present in exhaustible concentrated deposits of phosphate rock found in the state of Tennessee, in greater quantities in Florida, and in very large quantities in the far West. It is also found in dilute concentration in the nation's soil. With nitrogen and potassium, it supplies the major plant-food minerals required by growing crops.

The manner in which phosphorus can be used in the soil to expand the availability of inexhaustible resources is a fact of the greatest significance, and one which probably few engineers know about. One pound of phosphorus, an exhaustible mineral, makes it possible for legume plants and their bacteria to "fix" five pounds of nitrogen from the air into the soil. At the same time, the growing plants also draw carbon from the air and hydrogen and oxygen from water to produce sugars, starches, cellulose, and proteins. Phosphorus is thus one of the most important resources in our heritage. By using a comparatively small quantity of it in the right way, we can multiply the quantity of the recurring resources which are available for continuous use year after year, as long as men live on the earth.

To appreciate the significance of the foregoing plant materials to man, consider what happens when they are consumed as food by livestock. Only six per cent of the materials in a beef animal are minerals and nitrogen originating in the soil; 94 per cent we get "for nothing," as far as the land is concerned. The land on which cattle are raised supplies the small quantities of minerals and nitrogen. They must be replaced by fertilization, but the grasses which the cattle eat perform a miracle, for they are nourished mainly by air and water and not from the soils as such. Neither air nor water is ever lost. Both are returned every year, and the amount available today is the same as it was millions of years ago.

Actually, it is not even necessary to replace the nitrogen in the soil from manufactured fertilizers if the right kinds of plants are used; legume plants like clovers reach into the air, catching more nitrogen than they can consume. Thus, livestock can be produced without any permanent draft on the soil's stored resources, if we will merely arrange to replace the comparatively small consumption of minerals such as phosphorus and, where needed, potash, calcium, magnesium, copper, and sulphur.

The addition of phosphorus as a fertilizer to the soils of the country for conservation purposes is proceeding under the Agricultural Adjustment Administration in many parts of the United States. Concentrated phosphate fertilizers made by an electric-furnace method are supplied for this purpose by private industry and by the Tennessee Valley Authority. The educational work of 24 state agricultural extension services cooperating with the Authority in phosphate test-demonstration programs by farmers is stimulating this AAA distribution as well as consumption through commercial channels. The replacement of the phosphorus losses and the widespread adoption by farmers of new cropping systems are building up the nation's soils to the point where it is hoped that it will be unnecessary for the plow again to break up the western plains in search of fertile soils to grow the food needs of a world at war. Blackouts from dust storms need not this time be a consequence of emergency measures.

However, farmers have not always found it practicable to manage their businesses in a way that will conserve their capital, the soil. An industrial counterpart of farm practices typical of the past would be for a steel manufacturer to tear down the framework of his factory to get the steel to fill his orders. Let us see what the results of such practices have been in a single instance and what remedies are available if we make it possible for farmers to work with the natural cycle.

The Vegetable-Oil Crop, Cotton. In the Southeast, historical conditions induced farmers to supply the world with one of its greatest raw materials, cotton fiber, made of carbon, hydrogen, and oxygen.

A coproduct of the cotton plant is cottonseed oil, also composed entirely of the chemical elements carbon, hydrogen, and oxygen. These elements come in turn from the inexhaustible sources of supply, air and water. The entire vegetable-oil

industry thus gets its raw material "for nothing" as far as the soil is concerned. It is a big industry, producing $180,000,000 of oils annually. These oils are in turn used by other industries—foods, paints, linoleum, and oilcloth—whose products are worth $900,000,000 each year.

However, under past methods of cultivation, the cotton system has left the land exposed to erosion by water. On the average, it is estimated that about thirteen tons of topsoil have been lost from the lands of the South for every bale of cotton shipped out. Furthermore, the South has exported to Europe and to the livestock regions of the United States by-products of cottonseed processing, namely, the meal or cake which contains most of the nitrogen and minerals taken from the soil by the cotton plant. The land suffers not only from the soil washed away, but from the loss of these minerals in the cottonseed meal. These two causes have resulted in exhausting the soil in the cotton belt over the last 75 years. In turn, farm incomes have been low, and the region as a whole has been a poor market for the manufactured products of the nation.

The remedy which the southern farmer is beginning to adopt is to feed his cottonseed meal to his own expanding livestock herds, and thus return the valuable minerals and nitrogen to the soil from which they came. As a further source of feed, livestock can use the expanded acreages of cover crops which are being grown on recommendations of the state agricultural colleges. This practice conserves the soil and prevents the silting of reservoirs back of dams. It is all part of a readjusted farm management program which is already producing results. This program is geared in with the natural cycle, working with nature instead of at cross-purposes to it.

Agricultural Raw Materials for Industry. Sixty-five per cent of the raw materials of industry (including food industries) come from agriculture, and 50 per cent of the products of the farm go to industry. An expansion in the raw materials which agriculture furnishes to industry will be a desirable way to improve rural incomes if these products can be grown so as not to deplete the soil. To accomplish this, most soils will need to be built up in fertility and then so managed in accordance with the natural cycle that the plant-food minerals removed in crops can be largely returned to the soil.

Industrial purchasers of farm products need to cooperate with farmers in providing for these improved cropping methods. Otherwise the expanding production of farm crops for industrial use will increase the already serious annual drains of plant-food elements from the soil.

The chemical industry, one of the key industries in time of war, is an important user of farm products. To illustrate, the du Pont Company has announced that in 1939 it purchased the following farm products for chemical consumption:

Vegetable oils, lb	41,365,000
Corn products, lb	12,855,000
Wood pulp, lb	141,000,000
Turpentine and pine resin, lb	8,416,000
Linters and purified cotton, lb	59,400,000
Cotton fabric, yarn, etc., lb	11,452,000

In total, these amount to 274,488,000 lb with a cost value of $14,000,000. All come from recurring sources of supply.

This same company makes synthetic urea for fertilizers, methyl alcohol for antifreeze, nylon for hosiery, and other products from the inexhaustible sources of air and water supplemented by the exhaustible resource, coal. The coal is used as a processing raw material in addition to its usual use in heating the factories and generating electrical energy for running them.

While technology can show us how to make maximum use of less exhaustible resources, we are apt to forget that we are still left completely dependent upon nature for our sources of all energy and materials, and upon certain inflexible laws by which these become available for use. Making things synthetically does not lessen this age-old dependence; it simply changes one natural source of supply for another. For example, substituting a nylon product for silk requires the use of coal as the source of the carbon which the silkworm gets through vegetation from the carbon dioxide of air. The growing of plants in chemical solutions under artificial light does not require less of the plant-food elements, nitrogen, phosphorus, and potassium; the only difference is that these must be mined and transported from concentrated deposits instead of being drawn from dilute but widespread sources in the soil, available through conventional farming methods.

ENERGY FROM SOILS

Another reason for building soil fertility is that agricultural crops furnish not only the mineral elements needed to build living bodies of animals and human beings, but also the sources of energy which enable these bodies to do useful work. Demands on the energy which the soil can supply can be expected to expand in a national emergency requiring increased physical effort of the population.

One bushel of corn, if fed to a work animal, will make available 80 hp-hr of net mechanical energy, after energy losses in digestion and wastes have been subtracted.

By stopping erosion and then applying phosphate and lime and rotating grain crops with legumes, land can be built up to yield bigger crops and hence more available energy. Steps to improve soil fertility in the case of corn have resulted in increasing yields generally from about 15 bushels per acre to about 45 bushels in regions where soils have been depleted. Such an increase of 30 bushels makes available 2400 hp-hr per acre.

It is interesting to compare the cost of getting an equivalent amount of energy from other sources; for example, as electricity at low farm rates, 2400 hp-hr, which is 1800 kwhr, would cost $45. Against this must be set the cost for phosphate, lime, and labor in building up the energy-producing power of the land from the level of 15 bushels to 45 bushels per acre; this would cost roughly $25 per acre annually over a 5-year period. The net gain from the extra 2400 hp-hr obtained from the soil would be $20 on this basis. Once increased, however, this energy-producing capacity can be maintained at much less expense.

These figures indicate that under certain circumstances—on thousands of soil-depleted farms for instance—an economical way of capturing energy is by the cooperation of land, water, and sunlight through the growing power of plants. Since animal power is the way in which energy so obtained is used in this illustration, the applicability of the method is of course limited.

Other suggested methods can give us energy from the soil in forms having wider applications. One proposal which has had a partial trial is to make alcohol from crops for use as a supplementary motor fuel. On a purely cost basis this is probably not feasible in this country at the present price of gasoline. A more recent proposal was made at the September, 1940, meeting of the American Chemical Society, where Dr. Ernst Berl of the Carnegie Institute of Technology reported that he had made experimental quantities of petroleum and coal from carbohydrates in such forms as grass, wood, and corn. Under proper conditions, this transformation is reported to take place in the laboratory in one hour instead of the millions of years which nature was thought to require.

Dr. Berl pointed out that "coal as well as oil shales are put at our disposition by nature only once. As soon as we have used this material, it is gone. With carbohydrates, this is different. Nature produces carbohydrates every year anew with

the greatest ease. We can be rather liberal with those materials which nature puts at our disposition through growing plants and animals living on these plants every year, but we have to be extremely careful with those deposits which are at our disposition only once."

Petroleum. This stored resource is dwindling rapidly at the rate of one billion barrels a year in this country. Although new supplies are being discovered from time to time, it is obvious that discovering a supply which we did not previously know about does not in the least increase the total reserves which have always existed. Practically all authorities agree that the total amount of our reserves was probably fixed millions of years ago. The increasing dependence which our present civilization puts on this source of energy and the tremendous drains on it in time of war make this a matter to get concerned about in this generation. The trends in our sources of energy for motive power have been in the wrong direction. In earlier days men moved about by walking or using animal power, both of which draw on recurring sources of supply. Even wood used in the earlier locomotives could be replenished from recurring sources. When we began to use coal it was time to begin thinking, and now that petroleum is our main source of motive power, we must watch our step.

We can turn to the war situation for light on what we might do when our petroleum sources become too scarce to use freely. Let us see what Europe has done in such a situation.

One thing Germany has done, in addition to making gasoline from low-grade coal, is to operate some of her military vehicles by gas producers fueled with charcoal, or chipped-up wood.

As reported in the October, 1940, issue of MECHANICAL ENGINEERING, page 746, one of the larger British manufacturing companies has developed an improved gas-plant unit, which is now being made and sold in large quantities for installation on automobiles, trucks, and buses. Coal, coke, or charcoal is used for fuel with little or no change in the carburetion. The TVA is testing out a gas producer hardly bigger than an automobile gas tank, which can run a truck or be used to furnish stationary power. The trouble with this source of supply is that we would have to use one tenth of our present annual wood consumption in order to get the power we now obtain from gasoline. However, we might use the enormous supplies of waste and cull timber for some of our military vehicles or peacetime agricultural machines.

The use of petroleum in the mechanization of farming is particularly at odds with the thesis that we should draw on recurring rather than irreplaceable resources, since the former can be grown on the farm. For the small farmer who can grow most of his own feedstuffs for animal power, this following of the natural cycle was often shown during the depression to be more secure than dependence upon purchased fuel. On the day when the farmer can run his trucks with alcohol made from farm wastes or with charcoal from cull timber, or drive his Diesel tractor with vegetable oils, he will have reached the point of getting the advantages of mechanical power while still drawing on replaceable sources of energy.

SUGGESTIONS FOR ENGINEERING RESEARCH AND INDUSTRIAL POLICY

The engineer, as a member of a profession which aspires to utilize the forces of nature for the benefit of man, assumes an obligation to make his individual decisions conform with sound long-time strategy wherever and whenever possible.

The following illustrative suggestions[4] relate to such decisions in regard to the wide use of four types of resources:

Metals. Use what metals are needed, but do not waste; substitute ores from more plentiful reserves or lower grades; recover as much as possible from ore reserves; re-use as scrap metals.

Nonmetallic Minerals. Draw on inexhaustible sources such as air, water, and the sea; use common materials in the earth's crust like limestone, clays, and silica sand; recover from waste products like smelter gases; make synthetic products from inexhaustible or recurring sources, as well as from by-products of coal and petroleum.

Agricultural Materials. Use phosphorus and lime with legumes as a means of getting much greater quantities of nitrogen, carbon, and hydrogen from air and water to produce cellulose, starches, fats, and proteins; learn to grow energy and raw materials for industry on the farm without depleting the soil.

Fuels. Find substitutes for petroleum before it is gone; do not displace animal power from all farms, since its energy comes from recurring sources; learn to utilize the sun's energy more directly; do not expect that tapping atomic energy or other developments still in the idea stage is going to release us from dependence upon existing known sources of energy. There is no such release in sight.

We are in a better position than ever before to carry out the conclusions to which thirty-year thinking leads us, since industry now has a wider choice both of raw materials and of sources of energy to do the work. Furthermore, much of our scientific and engineering research in the future can be directed toward expanding the ways to substitute *recurring* for *exhaustible* materials and energy.

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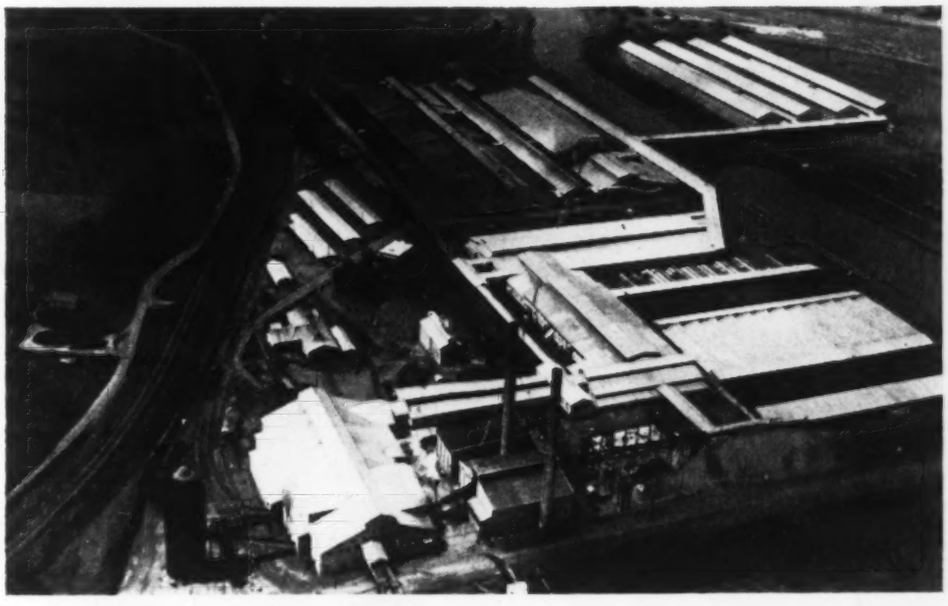
[4] See also "The Storehouse of Civilization," by C. C. Furnas, pp. 387–390. Bureau of Publications, Teachers College, Columbia University, 1939.

Courtesy N. Y. Convention Bureau

NEW YORK SKY LINE AT NIGHT

(See Program of A.S.M.E. 1940 Annual Meeting, pages 848–849 of this issue.)



AERIAL VIEW OF LEWISTON, IDAHO, PLANT

MATERIALS HANDLING *in the World's Largest* PINE SAWMILL

By D. S. TROY

SHIPPING SUPERINTENDENT, POTLATCH FORESTS, INC., LEWISTON, IDAHO

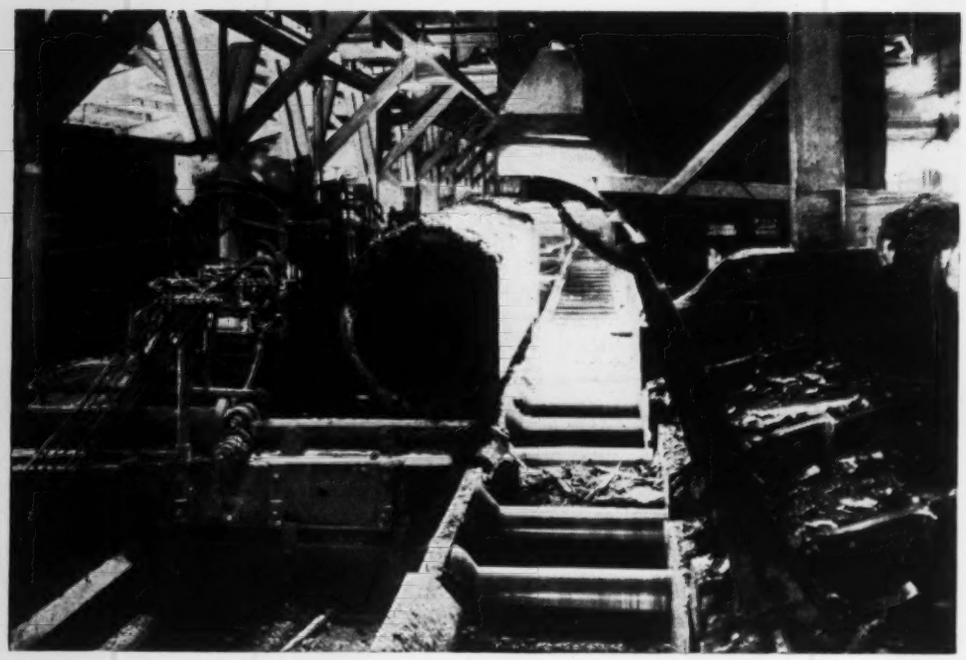
MATERIALS handling in the lumber industry is paramount to a well-balanced, smoothly operating, and efficient organization. It is a most vital requirement to each individual department and completely necessary for harmonious relationship and functioning of all units.

Methods of handling materials in the lumber industry are subject to change at all times depending largely upon the demands made by the customer. Not so long ago mills were favored with a nice volume of very attractive orders such as straight carloads of boards, shiplap, or drop siding. Orders such as these did not create the present problem of handling large numbers of items now ordered in practically every car and known to present-day lumber operators as "drug-store" orders. Nor was it necessary to accept the now ever-present party-car orders, for which two or more dealers club together and have their meager requirements shipped in one car with each item segregated and yet so arranged that each purchaser's complete shipment can be unloaded without disturbing the others. Moreover, mills were not required to handle stopover cars, originating on the West Coast and partially loaded with fir lumber to be halted at a pine mill for completion of the loading within 24 hours after arrival. These oddities were born with the depression, when a lumber dealer was forced to balance his entire stock with each car ordered or did not have the money to buy a full carload and was compelled to pool his requirements with other dealers in the immediate vicinity.

While the lumber dealers or customers were making their demands about 1932, the mills were hungry for orders. Competition was built on mill service and the railroads were soliciting business on service guarantees. Now that business has regained some of its normal volume, the attractive straight-car orders have not returned. Lumber dealers have permanently shifted the responsibility of keeping their stocks in balance to the manufacturer and the manufacturer must do all in his power to fulfill requirements.

Each year brings additional demands as well as improvements in manufacture. For example, a few years ago 15 to 20 per cent of shipments were requested to be smooth end-trimmed; today this has increased from 75 to 80 per cent. It is now necessary to stamp each board with the species identification, grade mark, and mill identification when, but a short time ago, this was unthought of. It is not the author's intention to create the impression that these changes in manufacture are detrimental or should be criticized in any way. Many of them are beneficial to the manufacturer as well as to the dealer. The point is that all of these changes in manufacture tend to alter the system of operation. The volume of orders may remain the same, but the increase in items and changes in manufacture make it necessary for a modern lumber operator to meet these additional requirements. All items of lumber must be kept readily accessible for quick movement into the cars and in their respective order.

Contributed by the Materials Handling Division and presented at the Fall Meeting, Spokane, Wash., September 3–6, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.



SAWING LUMBER, SHOWING ROLL-WAYS

Transportation, or materials-handling facilities, must keep pace with these changes. Volume must be maintained, costs must be kept down, and, please remember: "The customer is always right."

ESSENTIAL CONSIDERATIONS FOR EFFICIENT MATERIALS HANDLING

Preliminary organization and intelligent planning are prerequisites of materials handling. At the Lewiston plant, for example, an attempt is made to do this before any actual work is done. Let us assume for the moment that we are preparing a day's operation. Our two shipping clerks have been picking orders for several days in advance and have selected some twenty cars aggregating approximately 500,000 fbm. These orders have been picked with the idea of supplying each piece of operating equipment with a capacity run for one day. Considerable thought has been given to stock limitations, source of supply, and transportation facilities within and between all departments. Our handling department must not be overtaxed, yet must be kept functioning at near capacity. The day's block of orders so selected is then broken down into operating units. For example, the total amount of straight run, rerun, resawing, ripping, trimming, rough grading, and so forth are recapitulated.

The next step is the daily shipping meeting, held at 10:00 a.m. and lasting approximately 40 minutes. These meetings are for the purpose of reviewing the entire block of orders with all department heads and foremen and are held each day for the discussion of the following day's operation. As a result, due to the size of this particular operation, at one time we are working on the train requirements for three days, those for yesterday, today, and tomorrow; equivalent to approximately sixty cars of lumber.

The meetings prove extremely interesting and beneficial. Each department head knows exactly what is expected of his department each day and whether or not he is maintaining his required balance in relation to other departments. Complete coordination is essential to assure delivery of all items in their respective order to the car doors for immediate loading. An important sidelight on these meetings is that an opportunity is provided for settling all departmental grievances, complaints, and petty quarrels which are likely to arise in any well-regulated family and if not settled quickly are very likely to fester and develop into something more serious.

Our materials-handling head or, as we call him, transportation foreman, is an important figure at the shipping meetings. He is required to meet the demands of each department. They rely upon him for service, and if that is not forthcoming his lot quickly becomes an unhappy one.

SCHEDULING OPERATIONS

Following the shipping meeting, the block of orders is turned over to the planning or scheduling desk. At this desk individual tickets are made out for each item and all items are scheduled from their source through all the necessary manufacturing departments to the loading dock. Only recently, we have gone so far as to place the time of arrival of materials at the various manufacturing departments on the tickets and have accomplished a great deal toward maintaining the schedule closely. Much detail, such as breakdowns, anticipated degrade of lumber, transportation problems, shortages, and the like, must be absorbed by this planning desk. It is the author's belief that the work at this point is essential to successful shipping in a plant of this size.

Next in importance to the scheduling of each day's operation is the movement or handling of the product. Should the transportation lag, all the preliminary work of selecting orders, scheduling, and planning will have been to no avail. Scheduled shipments are delayed, departmental team work is lost, transportation becomes plugged, and the storage of lumber en route becomes necessary until a balance is resumed.

Some readers no doubt will raise the question: "What do you do when there is no sizable order file with which to balance a day's operation?" When this happens, and it has a number of times, it becomes necessary to balance the operation to fit what orders there are rather than to balance the orders to fit the operation. However, we must all agree that a sizable order file is perhaps the reason for the large sums of money expended on manufacturing.

HANDLING PRODUCTS THROUGH THE MILL

The actual handling problem does not begin until the lumber has been sawed, marked for drying segregation, and has traveled via the green chain to the drop sorter. From the log slip in the sawmill to the green chain, the lumber is moved by a system of roller conveyers and chains with practically no manual labor involved. This system was designed by sawmill architectural engineers when the original construction plans were drawn and so far no better system has been developed. The original cost of this installation was, of course, high but the operating and maintenance costs are exceptionally low.

As the lumber comes into the stacker building the first segregation, for lengths only, is made by five drop sorters. This is accomplished by first having one end of the lumber butted even

by end-press rolls before it goes over a series of chains. The even end of the lumber is carried on a continuous chain; the opposite chains are spaced at intervals to accommodate sorts of 6/8-ft, 10/12-ft, 14-ft, 16-ft, and 18/20-ft lengths. As the corresponding board lengths drop through the floor openings provided, the chain is discontinued. For example, the 6-ft chain carries the 6/8-ft lumber to the 8-ft floor pocket where it drops through and the 6-ft chain is discontinued. The 10-ft chain continues and carries the 10/12-ft lumber to the 12-ft pocket and so on with each length until the sorts for five-length segregations have been made.

This sorted lumber is dropped by means of inclined chains to the edge roll-feed chains for the next separation. It requires but three men to operate the drop sorter, their work being mainly to keep the lumber straight on the chain so that each length will be free to drop into its respective pocket. The entire sawmill cut, of some 400,000 board feet per eight-hour shift, is handled through this department and for a labor cost of but .021 cents a thousand board feet.

Separations on a basis of thickness and drying segregation are made at the edge sorter. The lumber is fed on edge into marked slots and carried by live rolls to its particular storage pocket. The labor cost at the edge sorters amounts to about 9.8 cents per thousand board feet. From the storage pockets, the lumber is fed on roller conveyers to the stackers where it is hand-stacked on kiln trucks. The kiln trucks are on automatic hoists which raise the trucks to the working level and lower the load as each course of lumber is stacked, thus maintaining a constant working height.

The lumber is moved from the stackers to the kilns and from the kilns to the unstacker by electric transfers. These transfers move an average of 1,660,000 board feet per 24-hour day, an operation for which the labor cost is 2.8 cents a thousand board feet. For a number of years lumber to be air-dried was sent from the stackers to the yard in solid units for hand-piling, but recently narrow-gage tracks have been installed on the transfers to accommodate yard-railroad trucks and the yard railroad was extended to the transfer track. In addition a trailer was added to the transfer to expedite movement of the units from the stacker to the yard-railroad system. This enables us to stack and sticker the lumber to be air-dried on yard trucks and to move it directly, without rehandling, to the yard, where the units are piled with the yard lift truck for drying. Thus, hand-piling and loading the lumber in the yard is eliminated; the stickers are removed as the stock is being run in the planing mill.

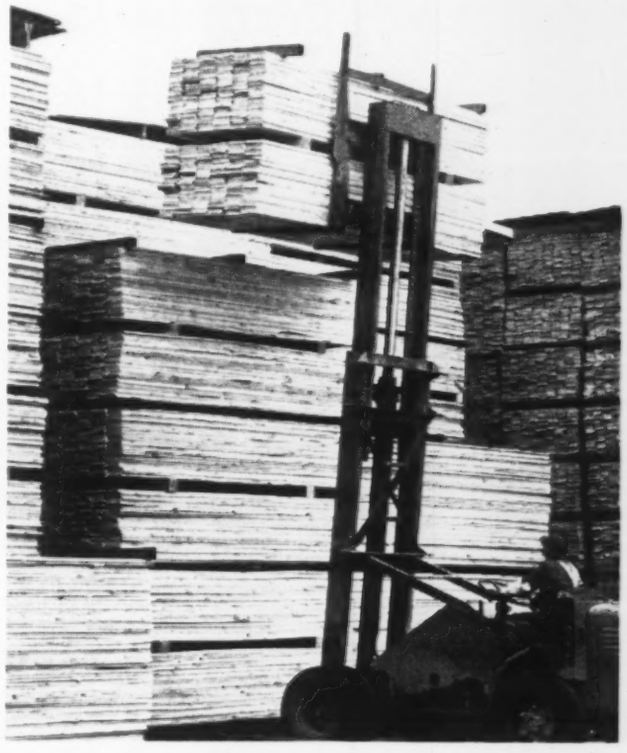
After the kiln loads are taken down by the unstacker, about 450 sorts are made on a system of chains, tables, and transfers, constituting the dry sorter. The lumber is put up in unit packages according to thickness, width, length, and grade. As originally set up, monorails carried the units from the pockets in the dry sorter to the rough sheds, yard railroad, and planing mill. As a result of extensive studies, it was decided to extend the yard-railroad system to the dry sorter and through the rough sheds. A monorail now serves the dry sorter, carrying the units from the pockets to the railroad and the railroad transports the units to the rough sheds, the yard, and the bridge-storage tracks.

These changes shortened the haul for the monorail, which can only move one load at a time, from a distance of 1000 ft to 175 ft on lumber for the rough sheds and from 325 ft to 175 ft on lumber going to the yard. The long hauls are now made by the yard railroad, which moves 10 to 15 units at a time about as fast as a single unit. When it is considered that the locomotive haul from the unstacker to the rough sheds is one-third mile and that from the unstacker to the yard is one-half mile, it is easily seen how important a "train" becomes. In spite of the difference in the length of average haul for the monorails, as compared to the locomotives, the cost of moving a thousand board feet by the monorail system amounted to 7.4 cents for the first five months of this year and 6.9 cents for the yard-railroad system. According to mill terminology, lumber is "moved" whenever it is picked up in one department and set down in another regardless of the distance involved. Therefore, it is well to keep in mind that monorails are primarily used in taking lumber out of storage and placing it on trucks or rolls for further movement.

HIGH COST OF MONORAIL SYSTEM

The extension of the yard railroad from the unstacker through the rough sheds cost approximately $3000 but the elimination of $1^1/_2$ monorails resulted in a saving of $575 a month which means that the investment was amortized within six months. The high cost of maintenance on the monorail system in comparison to the yard-railroad system makes it desirable to reduce the use of this type of equipment. As an example of this, on the $2^1/_2$ miles of monorail track it costs 26 cents a foot to replace the trolley, $1.86 a foot to weld and rebuild track, or $4 a foot to replace it with a new track. In this connection, it is interesting to note that, during the first six months of 1940, each monorail moved an average of 240,000 board feet per shift, as compared to 292,000 fbm per shift for each locomotive. What a difference this 20 per cent in volume would make if costs were figured on a ton-mile or on some footage-distance basis!

Before these changes were made, monorails carried the lumber from the rough sheds or yard railroad to the planing mill. With the extension of the railroad into the rough sheds, locomotives haul the stock from the rough sheds and the yard to the bridge-storage tracks for movement to the planing mill by monorails according to schedule, thus reducing the monorail haul from 1200 to 400 ft in the instance of lumber coming from



STACKING ROUGH LUMBER WITH YARD LIFT TRUCK

the rough sheds. One factor which made it practicable to use the yard railroad to a greater degree was the purchase of an end-lift truck for use in the yard.

Undoubtedly, the most important recent advancement in materials handling made at Lewiston was the purchase of this lift truck to handle unit-size packages in and out of the yard, piling them four high to approximately 25 ft to the top of the fourth unit. These units are separated by 5 × 5-in. bunks, allowing ample room for the insertion of the fingers of the hoist between packages.

Prior to the purchase of this machine R. T. Bowling, chief engineer, designed an electric piler which we used for a period of 10 years. Frankly, it was felt that, in this equipment, we had the most modern machinery on the market for handling storage-yard lumber cheaply and efficiently; without a doubt, this machine saved us thousands of dollars. Most of us had resigned ourselves to the fact that we were doing a good job in the yard and were perhaps years ahead of any other storage-yard-handling developments.

REARRANGING FOR LIFT-TRUCK OPERATION

When lift trucks became available on the market, at first we were somewhat reluctant to believe that it might be possible to better the performance of our electric piler, designed especially for our plant and by our engineer. However, there were some disadvantages to the electric piler. It traveled on narrow-gage railroad track and required the constant service of a yard locomotive to transport it as well as spot the empties and switch out the loaded trucks. It was necessary to provide permanent foundations for each length of lumber, which of course meant the lumber piles were necessarily spread over a large area. It required the use of a large number of trucks, and from twenty to thirty minutes were required to set up the machine at each pile. Furthermore, the piles were scattered, which meant that yard service was slow. Sometimes, it required two or three hours to gather a load for a customer whose lumber made up the bottom part of a car which we could not complete until it arrived from the yard, even though the balance or top parties were all at the car waiting to be loaded. However, in spite of these disadvantages, it cost but 14 to 16 cents per thousand board feet in or out of the storage yard, which any lumber operator will agree was very reasonable.

The advantages of the lift truck seemed to outweigh those of the electric machine, however, and it was decided to make the change early in the fall of 1939. It was necessary to change the arrangement of the entire yard to accommodate the new system efficiently. The narrow-gage railroad lines were torn out with the exception of feeder or trunk lines. The entire area was graded, graveled, and rolled before any units were piled. Portable foundations were made and piling was started. Because of the graveled base and portable foundations, it was possible to pile units of any length side by side, which meant more bottoms or items could be stored in a much smaller area.

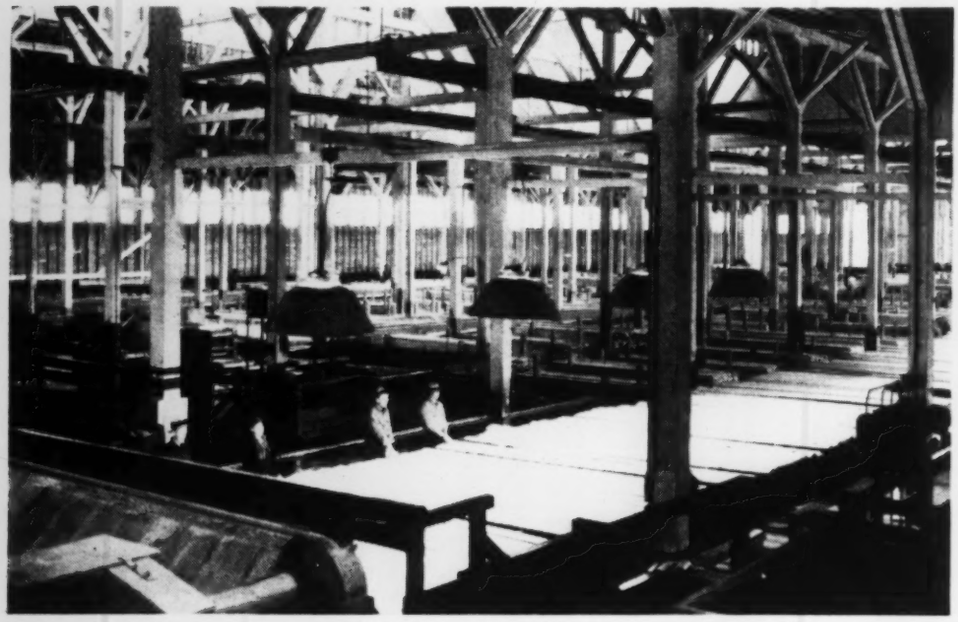
Under this system the yard locomotives spot the loaded cars along the feeder or trunk lines as close as possible to where the pile is to be made. It is important to keep the lift-truck haul to a minimum distance. Piling-and-loading organization is done to work out hauls both into and out of the yard each trip. In other words, when the lift-truck operator takes a load from the yard truck and places it on the pile, on his return, whenever possible, he will bring a unit to be loaded onto the empty truck for transporting to the planer or to the cars. The amount of organization work is of course unlimited and the more that is done the greater the reduction in costs.

The lift-truck system has reduced our costs for piling and loading solid kiln-dry units from 14 cents to 7 cents per thousand board feet handled. Green lumber stacked on short stickers at the stacker is machine-piled with the lift truck for approximately 11 cents per thousand board feet and loaded out for the same amount, or 22 cents per thousand for a round trip. The 11 cents for lift-truck piling added to the cost of hand-stacking which is 32 cents makes a total of 43 cents for piling green lumber. The average costs for hand-piling green lumber at this plant formerly were approximately 64 cents per thousand and for hand load-out 40 cents, for a total of $1.04.

At present, the piling and loading cost, using the lift truck, is 54 cents which represents a saving of 50 cents per thousand on all air-dried lumber. Needless to say, savings such as these are attractive. It is not impossible on a normal volume of business to pay for a complete change-over such as this, including the purchase of the necessary new equipment, within a short time.

In addition to these appreciable cost savings, our operation has been accelerated. Yard lumber is but ten to fifteen minutes from the planer or cars. Each pile is readily accessible and the entire yard system is more flexible. At Lewiston we refer to the change-over as "streamlining the lumber yard."

Lumber movements within the rough sheds, amounting to 302,000 board feet a shift per crane crew, are made with bridge cranes, one in each shed. Because of the fixed nature and high cost of this type of equipment, alterations and changes in operation are not readily made; however, very satisfac-



DRY SORTER; LUMBER IS MOVED TO LOCATION ON CHAINS AND REMOVED BY MONORAILS, TRACKS FOR WHICH ARE SHOWN OVERHEAD

tory results are obtained by these cranes on their particular job of handling, as is evidenced by the cost of less than 4 cents per thousand board feet.

TRANSPORTING LUMBER FROM PLANING MILL

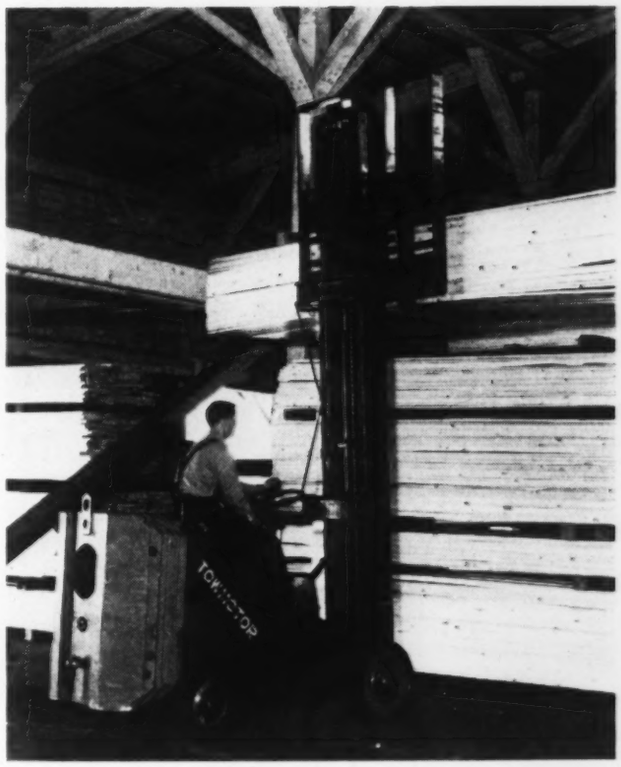
The changes in transportation from the planing mill to the remanufacturing plant, dressed dry shed, and shipping dock have been gradual and have taken place over a period of several years. Originally, all lumber was moved from machine to destination on lumber buggies pulled by electric tractors. Later a carrier was installed to supplement the tractors and buggies, the lumber being placed on bunks for transportation. As the carrier was faster in its handling, more and more footage was designated for it to move. Based on data for the first half of this year each tractor moved an average of 195,000 fbm per 8-hr shift and the carrier handled 177,000 fbm per shift. This difference in footage handled does not tell the whole story, as most of the hauls made by the tractors are interdepartmental (relatively short), while most of the hauls made by the carrier are also interdepartmental (but relatively long). Taken all in all, this handling costs from 5 to 6 cents per thousand board feet.

To make full use of the bunkloads made up for carrier transportation and to reduce further the handling costs, an end-lift truck similar to but smaller than the yard lift truck was purchased for use in the dress shed. On the basis of operations for the first four months of 1940, the cost of the lift truck, and changes incident to its installation, will be amortized in ten months. This lift-truck installation changed the dress-shed system from one of vertical hand piling to a combination of lift-truck bunk storage (horizontal piling) and vertical hand piling. Items ordered frequently or in considerable volume are handled by the lift truck. Slow-moving items, lumber ordered in small quantities (previously described as "drug-store" orders), shortages, and mixed loads make it necessary to maintain an inventory of vertical hand-piled stock. This lift truck handles 120,000 fbm per shift.

FURTHER CHANGES PLANNED IN HANDLING SYSTEM

Because of the high maintenance cost on the lumber buggies and electric tractors, congestion caused by empty buggies, loss of time when empty buggies are not available, and slowness of this means of transportation, consideration is being given to revision of this phase of the transportation system. It is believed that the next step, in meeting the handling problem and keeping the transportation system modern, will be the replacement of the six electric tractors and lumber buggies by four carriers. This change will require careful study as the main loading dock must be widened, an expensive undertaking; likewise, a large sum would be expended for new equipment.

The plant at Lewiston is fortunate in having diversified systems of transportation. We have studied their respective merits, limitations, and faults and have endeavored to classify the various handling problems and to apply the most efficient methods. The changes which have been made have proved

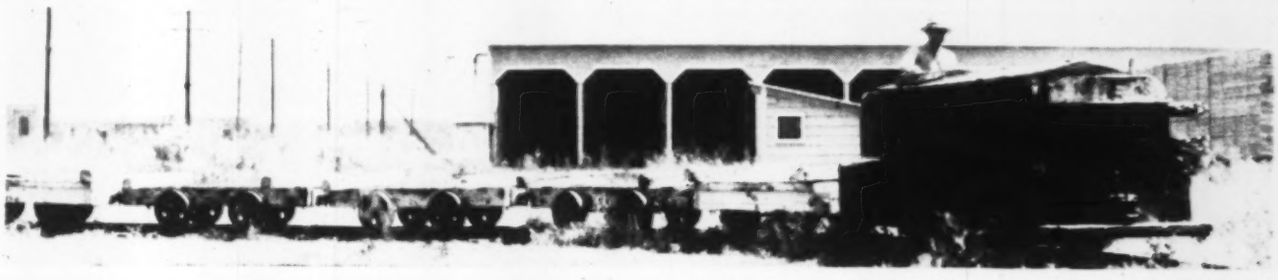


STACKING FINISHED LUMBER WITH PLANT LIFT TRUCK

valuable and have resulted in reduced costs or increased efficiency or both. Ten years ago, we would have ridiculed the changes that have come to pass just as we never dreamed of the demands made upon us by our present-day buyers. Ten years from now, if progress is made as consistently, we will undoubtedly have gone through a similar experience. It is important that we keep on the alert for new ideas and new methods. We should be quick to recognize them for their merits and applications to industry whether it be lumber manufacturing or any other.

Most of us are somewhat concerned as to the likelihood that the European war or our own national-defense program may stimulate a demand such that we may be called upon to double or even triple our present production. If this should happen, it will mean not merely additional shifts but will require reorganization, intelligent planning and scheduling, additional modern equipment, and, if you please, intelligent selling; all of which will result in new and different problems.

Materials handling will play an important part and will be a generous contributor toward the reduction of operating costs, just as it has been called upon to offset the more difficult shipping and wage advances during the last several years.



LOCOMOTIVE PULLING EMPTY CARS INTO POSITION ON NARROW-GAGE TRACK FOR LOADING BY MONORAIL

MOBILIZING A DEMOCRACY[1]

By FLOYD E. ARMSTRONG

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

WHEN a great democracy such as the United States prepares for war, problems and difficulties not immediately apparent confront the leadership of the nation. Underlying circumstances, largely absent in the dictatorships, present obstacles that slow down and retard the effort. The economy is geared to peacetime demands. The productive activities of the people are centered on the creation of the necessities and luxuries that satisfy peacetime wants. Specialized capital investment is directed toward such outlets and specialized labor is engaged with management in carrying out a "business-as-usual" psychology. They are not easily converted into a war machine. But in mobilizing for war, that conversion must be made, because for a nation to carry on a successful war today there can be no business except making war. The realization that mobilizing for modern war means utilizing everyone and everything for the common effort and that the outcome of long war will almost certainly destroy all existing economic relationships is certain to give pause to all who are fairly comfortably placed in the present economy. The fundamental patriotism of the propertied classes, for example, is put to a severe test when they contemplate the likelihood that, however the issue of battle may be resolved, for them the collapse of their structures of economic security and power is well-nigh inevitable. For promising youth and hopeful young manhood a similar test of patriotic purpose is presented. Their education is threatened and the realization of their hopes in love and business retarded or postponed if not entirely thwarted. For organized labor there is the ever-present fear that wartime demands and the pressure of a public opinion intent only on satisfying the call of the armed forces will set back their struggle for a more favored position in the economy or even rob them of some of their hard-won gains. Small wonder that, when war threatens, there should arise an appeasement policy, with hopes for "peace in our time," or that youth movements against war should emerge. Yet these influences must be countered and suppressed if mobilization shall proceed, for they are a part of that democracy that must be brought into a oneness of purpose if the effort is to succeed. No Fascist Duce can command. No Nazi Fuehrer can summon and dispatch. Democracy cannot be ordered. It must rise in its own might and move of its own volition. And democracy—just because it is democracy—is a sprawling mass of inconsistencies and opposing wills. The problem of national leadership—when that leadership decides on war—is therefore to reduce such inconsistencies and conflicting views to a harmonious and united effort.

To accomplish the task of molding public opinion to the ends desired, the arts of propaganda and the machinery of censorship are the most useful tools. "Propaganda acts positively; by directing a stream of selected information and suggestion into the public consciousness, it aims to create attitudes favorable to loyalty and sacrifice. Censorship acts negatively; its aim is twofold: (1) To keep out of the public press, the motion pictures, the radio, and even oral communications, information and opinions which might weaken popular enthusiasm for the war; and (2) to keep from the enemy information of value to him."[2] Censorship is rather generally accepted and approved by the citizenship but the word propaganda has come to have a sinister and unsavory meaning. Many persons refuse to think of the process as other than socially objectionable. Yet it is almost axiomatic that a war fought by an industrialized nation in an industrial era must have the full and complete support of the people if it is to be crowned with military success. Victory may depend not so much on the skill of the generals or the fighting quality of the troops as on the effective organization of the economy behind the lines. It has been estimated that to maintain one American soldier in the trenches—to feed and clothe him and maintain him with all required materials—will demand the services of from six to ten workers on the home front. An apathetic and indifferent home front would certainly spell defeat. Propaganda for the common cause becomes then not only permissible but absolutely essential in a nation operating through the democratic process. In the last World War, an America rather indifferent at the beginning to the cause of France and England soon came to be as enthusiastic and unanimous in its approval of the righteousness of the Allied cause as the most patriotic citizen of those nations. We were in, and our Committee on Public Information (a much less objectionable name than, let us say, the Department of Propaganda) proceeded to sell the Allied cause to the American people. The efforts of that committee in an intense and unceasing emotional and intellectual bombardment of the public mind would not suffer by comparison with those of any other nation. They were outclassed, if at all, only by the subtle and convincing work of the English. And, again, it should be realized that to mobilize a democracy to successful war effort, the work done by such a group is an absolutely necessary complement to the work of the army and the fleet. We may be sure that the War Department plans for mobilizing our nation if war should come do not omit this important item.

A disturbing circumstance that is sure to develop when a nation mobilizes for war is the ineffective and unsatisfactory working of the usual controls of free enterprise. One may criticize with convincing argument all proposals for substituting a planned economy for a free economy in times of peace; but in war, authoritative controls must displace the automatic controls of the market in large segments of the economy. It becomes obvious at once that a vital question about wartime controls is: Who shall operate them? The particular reason why this question is so vital to the people is the possibility or indeed the probability that the vast powers that must be granted to and exercised by the nation's leaders during the duration of the war emergency will be retained by those leaders or their successors in power, long after the circumstance of war has passed. This danger would appear to be especially threatening if the emergency war powers were extended to an administration that had already sought and obtained extraordinary authority to meet previously existing economic distress or social difficulties. And it would appear to be even more alarming if that administration happened to embrace among its influential officials and advisers a substantial number

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, The Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "Mobilizing Civilian America," by Harold J. Tobin and Percy W. Bidwell, Council on Foreign Relations, New York, N. Y., 276 pp., $2.75.

of persons who believed in a planned economy and a system of authoritative controls as the correct form of organization for society even in normal times. And so the question of who shall really use the controls in a wartime economy is of paramount importance.

There are in fact only two practicable answers: (1) The existing executive agencies and others that may be created; or (2) civilians drawn in from industry as heads of emergency agencies, to act for the duration of the war. Considering the fact that the work to be done (apart from the work of the armed forces, which is of course under the control of the generals and admirals) is made up largely of the organization and operation of industrial activities, it would seem as though the choice of the second alternative would be the obviously correct one. Such is in fact the recommendation in our present plan for industrial mobilization, but recent as well as past experience does not indicate a complete willingness on the part of government officials to clothe with authority and charge with responsibility those industrialists who would be summoned to the task of industrial mobilization. The recently appointed members of the Defense Commission have only an advisory function and lack a committee head and the power to act. And so perhaps the most we can hope is to expect a combination of the two alternatives proposed. If it should develop that in a combination of such varied elements, men of force and ability should be placed in key positions as the representatives of industry and if it should develop that the jobs to be done were beyond the scope and capacity of the political leaders (and they should be wise enough to realize it), then it might well follow that the industrial mobilization process would be effectively carried out and dire necessity prevent the actual assumption and exercise of authority by those who would be loath to surrender it.

Specifically, the following items should be included as important in the actual process of mobilizing the nation's resources and operating them for the prosecution of the war: (1) Mobilizing the armed forces; (2) mobilizing industrial labor; (3) mobilizing business; (4) mobilizing agriculture; (5) mobilizing the controls of war finance; (6) mobilizing the controls of foreign trade; (7) mobilizing the controls of prices and profits.

The task of mobilizing the armed forces has two parts: (1) The actual bringing into combat condition the army and the fleet as at present constituted and (2) the task of bringing into the armed forces the additional man power that it has been decided to recruit. And here of course there emerges the question of how to get that man power. Two available methods exist—voluntary enlistment and conscription. Notwithstanding the arguments that may be advanced for the former, the nations of the world have almost unanimously adopted the latter, and the principle of selective service is now a part of our American system and so the question of how to raise our armies possesses only academic interest. Probably the strongest argument for selective service is that under that plan the government may obtain its needed recruits with the minimum of disturbance to the effectiveness of the industrial machine—this of course because it may draw from sources where the continuance of maximum output may not be important, leaving undisturbed those reservoirs of labor whose continuing work in industry may be essential to the functioning of the war machine.

The general problem of mobilizing industrial labor has been herein indicated but there are a large number of questions that arise as corollaries to the major problem. Among them may be mentioned: (1) The dislocation of industry due to sudden changes in demand for laborers and accompanying upsetting of wage differentials. In the former World War thousands of women left schoolteaching and household duties to work in munitions factories. Great armies of laborers journeyed from small towns and factories to find more remunerative jobs in war work. (2) As a result of the foregoing fact of dislocation and labor unrest, a greater and greater measure of control over wages and hours becomes inevitable. In reverse, so to speak, this is likely to be carried over into our postwar economy. (3) Labor compulsion is sure to occur in all warring nations, as the slogan "Work or fight" becomes effective in law. (4) An actual and destructive lack of labor will occur in many industries, that are quite unable to compete with the wages offered in the war industries and related lines. It may be noted in this connection that with perhaps 9 million men unemployed, industrial mobilization at the present time should be relieved in part from this last-mentioned danger.

The mobilization of business presents two important problems not previously mentioned. (1) The question of priorities and (2) the question of commandeering plants for war needs when and if the owners fail to meet the requirements of the government. It has been the traditional policy of the American Government to rely on the patriotic willingness of business managers and owners to serve the needs of the country as they have arisen. In almost every instance business has met this situation to the complete satisfaction of all. In the former World War under the able direction of Mr. Baruch, almost no difficulties were encountered in the application of the law that gave the government full and complete service and priority in purchase when desired. It is safe to predict that the coercive terms of our recently enacted legislation covering these points will rarely if ever be applied.

Finally, there remains the question of price controls. As indicated in the paragraph on mobilizing labor, the pressing and urgent demands of the war industries inevitably throw the economy out of balance and the processes of the market will establish prices destructive to certain interests and unbearable to the nation itself. In September, 1917, President Wilson found it necessary in conjunction with the War Industries Board and with the authority of the statute creating that body to establish maximum prices for copper, iron, and steel. In the following fourteen months, hundreds of articles were brought under arbitrary price controls. The objectives were principally two: First and foremost, a protection of the government itself in the purchase of essentials for its war effort; and second, the stabilizing of the price structure and the maintaining of a fairly balanced economy. This latter effort was not altogether successful, because while the government had power to fix prices, it did not have (and never can have under a free economy) the power to coerce production, except in the essential war industries themselves.

In conclusion it should be recorded that the United States has not been idle or negligent in taking the preliminary steps for a mobilizing effort. From time to time in the years following the last war tentative plans have been evolved for utilizing to the fullest extent the nation's resources should trouble come. Congress has authorized the War and Navy departments to cooperate with industry in all such efforts. Acting under that authority the heads of those arms of defense have prepared rather complete plans for utilizing the resources at our command. These plans recognize that the mobilizing of industry is a civilian task. Under them the Army and Navy authorities will determine what they need and the civilian organization that is contemplated in the arrangement will see that the requirements are fulfilled, while protecting the economic life of the country from unnecessary dislocation. The plan is by no means a complete blueprint of all things to be done, but it is at least a working arrangement that may be expanded and enlarged to cover all matters that experience may reveal as necessary to the task in hand.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Diesel-Electric Locomotives

LOS ANGELES SECTION, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

SINCE 1935, the Atchison, Topeka, & Sante Fe Railway Company has placed in service 41 Diesel-electric switching locomotives and 18 Diesel-electric high-speed passenger locomotives with a total power of 73,140 hp, comprising the largest fleet of Diesel-powered locomotives in use at the present time on any railroad. The design, operation, and maintenance of these locomotives were described in a paper presented at the July 17 meeting of the Los Angeles Section, The American Society of Mechanical Engineers, by H. V. Gill, supervisor of Diesel engines for the railroad. A similar paper by the same author appeared earlier in the April, 1940, issue of the *Railway Mechanical Engineer*, but did not contain information about the four passenger locomotives recently put into service. The abstract, which follows, is taken from the paper presented before the A.S.M.E.

The passenger-locomotive units are each powered with two 12-cyl, V-type, two-cycle Diesel engines, the horsepower rating being 1800 to 2000 hp per unit and the maximum speed with a 25:52 gear ratio is 117 mph. These units have accumulated 7,684,111 miles of service to June 1, 1940, with an availability of 95.3 per cent. Switching locomotives are powered with either the four-cycle or two-cycle Diesel engine. They have been available 94.3 per cent of the time during 1939. This availability of Diesel-electric locomotives is possible because they do not require extensive repairs, frequent watering or fueling, boiler washing, or fire cleaning. Because of the swivel truck and long wheel base, the elimination of reciprocating parts, and low center of gravity, the Diesel locomotive is easy on the track and will operate at high sustained speeds on fast schedules.

In a Diesel-electric switching locomotive, all of the weight is carried on the driving wheels, which gives an effective return for locomotive weight. Since the average speed for switching operations rarely exceeds 6 or 7 mph, by selecting the proper gear ratio between the traction motor and power axle (about 4:1), the Diesel-electric switcher will handle the work of a steam locomotive which has a horsepower rating of approximately two and one-half times that of the Diesel locomotive.

The aforementioned characteristics result in economical operation for both road and switching locomotives as indicated in cost of operation data shown in Tables 1 and 2, which do not include depreciation or wages of enginemen.

At the present time the electric transmission, an important and expensive part of the Diesel equipment, is one of the limiting factors in so far as continuous operation on heavy grades is concerned. This is due to the necessity of dissipating the thermal losses from the generators and traction motors. Another limiting factor which interferes with continuous operation of the Diesel-electric locomotive on heavy grades during hot weather is the dissipation of the tremendous amount of heat generated by the Diesel engines which is brought about by space limitations, weight-per-axle limitations, and the power required to drive cooling apparatus.

TABLE 1 OPERATING COST OF 4000-HP DIESEL-ELECTRIC LOCOMOTIVES IN HIGH-STEEL PASSENGER SERVICE, YEAR 1939

	Cost per locomotive-mile
Fuel	$0.123
Locomotive repairs, labor and material	0.137
Lubrication	0.011
Supplies	0.007
Water	..
Total cost per mile	$0.278

TABLE 2 COST OF OPERATION PER SERVICE HOUR IN SWITCHING SERVICE

	600-hp 2-cycle Diesel-electric, dollars	600-hp 4-cycle Diesel-electric, dollars	1000-hp 2-cycle Diesel-electric, dollars	1000-hp 4-cycle Diesel-electric, dollars	Steam locomotives Sante Fe 566 class, dollars
Fuel	0.199	0.290	0.261	0.282	1.53
Locomotive repairs, labor and material	0.286	0.143	0.336	0.119	1.12
Estimated cost of general repairs	0.250	0.250	0.250	0.250	..
Enginehouse expense	0.060	0.046	0.028	0.026	1.38
Lubrication	0.073	0.033	0.045	0.022	0.06
Supplies	0.009	0.013	0.014	0.021	0.04
Water	...	...	...	...	0.30
Total per service hour	0.877	0.775	0.934	0.720	4.43

Approximately 63 per cent of the repair charges to Diesel locomotives are for materials. Since these materials are expensive and changes in design are frequently made, it has become necessary to set up a special plan to govern the supply of new repair parts on hand and the handling of worn or defective materials over the system. All requisitions for new materials and disposition of worn or defective parts are handled through a central point on the Sante Fe. Since the road locomotives, which are powered with two-cycle Diesel engines, are operated under a load factor of about 60 per cent, trouble has been experienced with the engines. In fact, the Diesel-engine maintenance expense comprises about 50 per cent of the total locomotive repair costs. In switching service, locomotives are assigned to three shifts, 24-hours-a-day service, in order to take full advantage of the savings possible with this type of power. These locomotives give little trouble due to a low load factor—about 15 per cent.

Switching locomotives are fueled two or three times a week while road locomotives run more than 600 miles between fuel and water stations. The use of air filters and oil filters has increased lubricating-oil drain periods from 5000 miles to 100,000 miles of service for the road units. In switching service, crankcase lubricating oil is changed every three to six months of service. The specifications for lubricating oils used are given in Table 3.

TABLE 3

	Road service	Switching service
Gravity	17.6	19.1
Flash, deg F	435	395
Fire, deg F	500	450
Viscosity at 210 F	85	62
Pour point, deg F	10	−10
Ash, per cent	0.003	0.003
Neutralization number, per cent	0.02	0.02
Carbon residue, per cent	0.25	0.07

Cylinder liners that were worn 0.050 to 0.060 in. in about 60,000 miles are not removed when worn 0.020 in. after 325,000 miles of service and reconditioned for use again. Cylinder heads are reconditioned or repaired every 100,000 miles by means of welding. Piston design has been improved. At the present time, the drop-forged aluminum piston with greatly increased ring land width is giving the most dependable service. Piston assemblies are removed for inspection every 100,000 miles and replaced after 220,000 miles of service. This mileage will be greatly increased as new-type pistons replace the older designs. Capacity of lubricating-oil pumps has been increased. Air for engine radiators is now carried through ducts eliminating dirt from this source getting into the engine rooms. These improvements make it possible to run a Diesel engine 100,000 miles in road service before it is dismantled for inspection.

Wheels on the locomotives have been greatly improved. The service life of present wheels is about 250,000 miles with about 84,000 miles between machinings. During the short development period through which the Diesel locomotive has gone, there has been a transition from a single-engine-powered car of 600 hp to locomotive units having two Diesel engines of 1000 hp each and operation of these units in multiples of two or three units making a Diesel locomotive of 4000 to 6000 hp.

Machine Tools in Peace and War

UNITED STATES DEPARTMENT OF COMMERCE

ALTHOUGH it is the world's leading producer, the American machine-tool industry is comparatively small as industries go in the United States, consisting mainly of moderately and privately financed and controlled units, turning out highly specialized types of equipment, declares David Longanecker in an article appearing in the Sept. 19, 1940, issue of *Domestic Commerce Weekly*, published by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce. The author traces the growth and development of the industry now playing a major part in the preparedness program.

The tremendous demands on the machine-tool industry during the World War brought about an annual production rate estimated roughly at $500,000,000 toward the close of the war in 1918, ten times the estimated $50,000,000 output in 1914. From 310 plants employing 30,082 workers in 1914, the industry expanded to 378 plants employing 77,194 workers in 1918. Following the war the number of plants and employees diminished, and the economic depression following 1929 seriously affected the industry. Improvement in the machine-tool industry was aided in 1934 and 1935 by greatly increased foreign purchases, particularly by Great Britain, Russia, Canada, and Japan. Foreign sales were an even greater factor in 1936, particularly to Great Britain and Russia and reaching a total of $32,270,000 for the year. In 1937 total United States machine-tool shipments abroad exceeded $47,600,000, while the domestic market absorbed $212,643,000 worth. The 47,266 workers in 292 plants in that year were paid $78,284,000 in wages or 30 per cent of the total value of the product. The number of wage earners, wages, and value of product in percentages by states for 1937 are shown in Fig. 1, a chart that is not contained in Mr. Longanecker's article, but which, in order to illustrate this abstract, was copied from the August, 1940, issue of *Pennsylvania Planning*, a publication of the State Planning Board of Pennsylvania.

Foreign orders continued to be placed in increasing volume after 1937, while domestic purchases dropped as a result of the business recession which set in at the close of that year and remained at lower levels until the outbreak of the war in September, 1939. Machine-tool exports jumped to $74,670,000 in 1938, shipments to Russia alone amounting to $26,162,000, to Japan $19,413,000, to Great Britain $10,380,000, and to France $5,047,000. During 1938 and again in 1939, when exports totaled $93,404,000, more than half of the total orders which were received by machine-tool builders were of foreign origin. During the year 1939 shipments to Great Britain amounted to $25,570,000, those to Japan $19,812,000, to France $17,104,000, and to Russia $15,414,000.

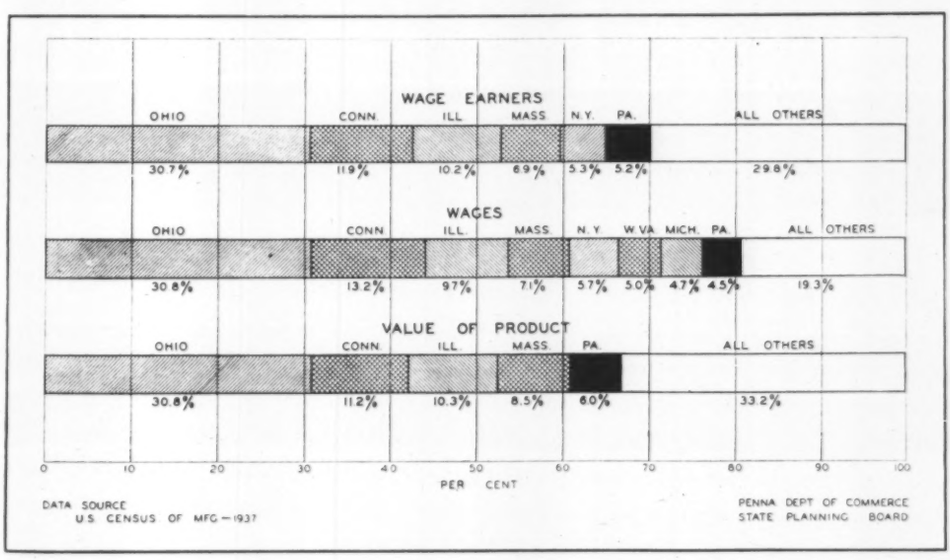


FIG. 1 WAGE EARNERS, WAGES, AND VALUE OF PRODUCT IN PERCENTAGES BY STATES FOR 1937 IN THE MACHINE-TOOL INDUSTRY

From 140 and 160 in August, 1939, the indexes of employment and pay rolls in the industry jumped to 156 and 182 in September, and in successive advances reached 193 and 257 in December, representing the highest levels attained since the World War. Machine-tool builders entered 1940 with a large backlog of both domestic and foreign orders. This backlog has increased despite continued expansion of the industry augmented by a greater use of the practice of "farming out," or subcontracting, for parts of assemblies. Developments in the European war and initiation of this country's defense program have added greatly to the already heavy

demands on the industry. In July of this year the machine-tool industry employment and pay-roll indexes stood at 235 and 308, respectively, gains of 42 and 52 points over the December, 1939, figures. Later figures are not available, but it is believed that the current annual rate of machine-tool production is near the peak attained during the World War.

Exports have been at even higher levels so far this year, but reached the maximum monthly value of $17,910,000 in April. They have declined steadily since then, owing mainly to the discontinuance of purchases by France. Since then, also, the United States Government has established control over the export of machine tools, as well as a priority system through which production is allocated according to the requirements of the national-defense program. From January through July of this year, however, machine tools valued at $99,670,000 were exported from the United States, more than were exported during the entire 12 months of 1939. Exports to Great Britain through July of this year totaled $38,469,000, to France $28,367,000, to Japan $12,052,000, to Russia $10,015,000, and to Canada $3,708,000.

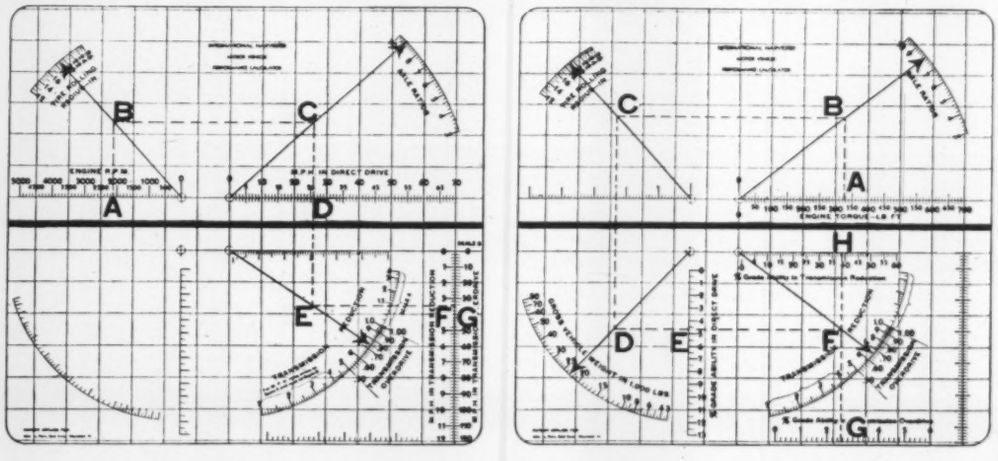
Power Industrial Trucks

MATERIAL-HANDLING HANDBOOK

EFFICIENT material-handling methods not only serve as a means of raising plant earning power, but also cut direct handling costs. The direct saving made by an industrial-truck handling system, compared to manual handling, has seldom been less than 25 per cent and, sometimes, has exceeded 90 per cent, claim the editors of the 56-page manual, entitled "Material-Handling Handbook" and published by the Industrial Truck Statistical Association, 208 S. LaSalle St., Chicago, Ill. Divided into four sections, the handbook covers the place of material handling in industrial management, material-handling management, the organization of an industrial-truck handling system, and practical power-truck engineering.

The various industrial-truck handling systems are classified and described under the following headings: Tractor trailer, platform truck, lowlift-truck-skid type, highlift-truck-skid type, fork-truck-pallet type, unit load, and special types, one of which was described in this section on page 741 of the October, 1940, issue of MECHANICAL ENGINEERING. Flat paper and tinplate were the first commodities for which power carloading and skid or pallet shipping were adopted. Industrial trucks are further classified as to the kind of power utilized, such as (1) battery-electric, which is powered by a storage battery and employs electric control and transmission, (2) gas-electric, which is powered by an engine-generator but is otherwise the same as the battery-electric, and (3) gas-mechanical, which is powered by a gasoline engine and employs mechanical control and transmission.

To enable the plant engineer to make his own analysis and recommendations for improving material handling, the manual provides information about methods of route analysis, building and modernizing the existing plant, operation and maintenance of industrial trucks, engineering, and costs.



ENGINEERS DESIGN SIMPLE MOTOR VEHICLE PERFORMANCE CALCULATOR

(Shown above are two views of an International Harvester Co. calculating instrument, which is 7 × 7½ in. when open, and made of two equal-size pieces of white bakelite joined by a continuous-type hinge. The four individual indicator arms, one for each function of performance ability, are made of a transparent acetate plastic. To find factors of road speeds, the indicator arms are set as shown in left view and results obtained as follows: (1) Mph in direct transmission, read A-B-C-D; (2) mph in overdrive, read A-B-C-E-G; (3) axle ratio in direct, read A-B-D, then place indicator at intersection C and get axle ratio, and so on. To find factors of grade ability, indicator arms are set as shown in right view and results obtained as follows: (1) Grade ability in reduction, read A-B-C-D-F-H; (2) engine torque required in direct, read E-D-C-B-A; (3) gross weight negotiable in direct transmission, read A-B-C-E, then place indicator at intersection D and get answer; (4) axle ratio required in reduction, read A-H-F-D-C, then set indicator at intersection B and obtain ratio, and so on.)

Visual Engineering Education

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

A STUDY made recently at one of the American colleges attributes three per cent of a man's conceptional knowledge to taste and smell, 15 per cent to miscellaneous organic experience, 17 per cent to tactile experiences, 25 per cent to hearing, and 40 per cent to sight. Therefore, it is all the more interesting to note the trend in visual education as described in papers presented at a special session during the annual meeting of the Society for the Promotion of Engineering Education held at Berkeley, Calif., June 24–28, 1940.

Prof. Justus Rising, Purdue University, in his paper, tells of the use of motion pictures to teach engineering drawing subjects, such as lettering, freehand drafting, orthographic projection, auxiliary views, sectional views, pictorial drafting, screw-thread representation, structural drawing, developments, and intersections. Besides using sound in conjunction with the showing of the motion pictures, the Purdue faculty has also introduced four new pedagogical features. In the first place they have undertaken the demonstration of topics involving both subject matter and skill. Secondly, every film is provided with an accompanying work sheet for each of the students on which he can work exercises involving the application of the principles demonstrated in the picture. Thirdly, motion pictures have been constructed in such a way as to demonstrate

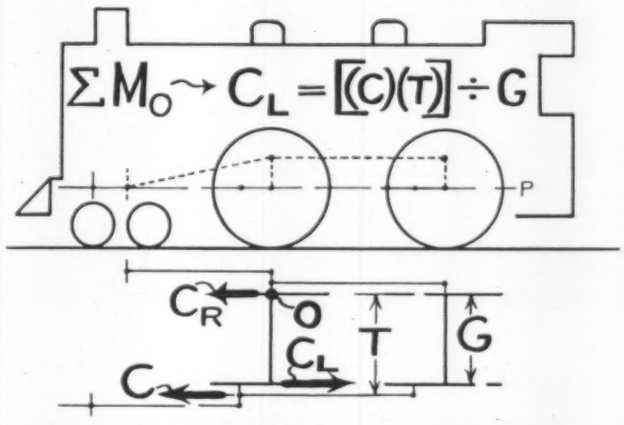


FIG. 2 A STILL TAKEN FROM THE N.Y.U. MOTION PICTURE ON THE COUNTERBALANCE OF A LOCOMOTIVE DRIVE WHEEL

only a few principles at a time with provision for stopping the film at frequent intervals so that the student may solve a problem based on the principles just demonstrated. Lastly, for each set of work problems there has been prepared an identical layout on a lantern slide for chalk-board projection by which the instructor shows the students his method of working the problems.

However, in the preparation of sound pictures two difficulties were encountered. First, if a silent picture was prepared and the "sound" put in by a commercial company, the expense was rather prohibitive. Second, if the sound picture was made by putting in the sound at the time the scene was being photographed, physical difficulties were encountered which prevented making the maximum use of such camera tricks as fade-ins, fade-outs, long shots, and close ups. Because of these difficulties, motion pictures made this year have been of the silent type, but instead of splicing in printed titles or "dubbing" in the sound effects, a precisely correlated commentary has been printed which the instructor reads as the film is projected. From the classroom standpoint the effect of this method is practically the same as for a regular sound-on-film motion picture, while from the standpoint of production it has three advantages: (1) The picture is simpler to produce, (2) it costs less, and (3) the commentary can be modified and improved as required.

The drafting course schedule at Purdue University provides a one-hour lecture at which the motion pictures are shown, and two two-hour drawing periods a week. The subject matter of the lecture and that of the drawing-room periods are correlated as closely as possible so that the student has an opportunity to work with instruments in the drawing room additional problems similar to the ones he has worked freehand in the lecture room. During the lecture period, the showing of the motion picture takes up from 12 to 15 min, while the rest of the time is spent by the students in working out three or four problems.

In discussing the utilization of motion pictures in the college of engineering at New York University, Dean William R. Bryans, member A.S.M.E., showed how the methods of Walt Disney in producing "Mickey Mouse" were borrowed by Prof. Charles E. Gus, member A.S.M.E., in preparing films for courses in engineering mechanics. In the course of his experiments with animated cartoons, Professor Gus developed a technique that materially reduces the physical labor of making a multiplicity of drawings. It consists of making one master drawing which contains all the phases of the complete cycle that are to be photographed. This original drawing is duplicated by the photo-offset process in a very pale blue color, and as many copies are printed as may be necessary. A second original drawing is then prepared, which shows all parts of the machine or picture that do not change from phase to phase. These parts would correspond to the scenery in a Mickey Mouse cartoon. This second drawing is photographed and overprinted in black on the photo-offset copies of the first drawing. The cost of these double prints is surprisingly low, being around $6 for 400 copies printed on 91-lb cardboard. All that then remains to be done before photographing these prints with the movie camera is to draw each phase of the motion in India ink on the individual prints. The prints are then placed one at a time in a simple jig and the black lines photographed on the film. The camera used must be capable of exposing a single frame at a time.

The difficulty encountered in stopping the film during projection to discuss different points was solved by Professor Gramath of the N.Y.U. physics department who rebuilt several 16-mm projectors to make possible still and reverse motion. Any one frame of the film may be held without danger of burning because of a window of Jena B.G. 21 glass which is permanently mounted behind the film and absorbs and radiates the heat from the 300-watt lamp. Furthermore, a remote-control box with cable permits the speaker to start, stop on any frame, or reverse the film, from any position in the room without moving the projector.

Probably one deterrent to the use of projection material in engineering courses lies in a traditional habit of thought. The idea of motion pictures or even slides connotes in the average instructor's mind the bother of setting up a screen, obtaining a projector and someone to run it, assigning the class to a special room equipped with dark shades, and the loss of valuable class time. If projected pictures, either movies or stills, are to be useful supplements to teaching, Dean Bryans suggests more classrooms equipped with dark shades, permanently placed projectors, and permanent screens. The permanent screen may be an ivory-colored plastic which answers the dual purpose of screen and superior substitute for a blackboard. In such a room short three- to five-minute films or eight to ten slides can be exceedingly useful and do not ruin a discussion hour. Experiments at N.Y.U. have even included the projection of films or slides through the plastic blackboard from the rear. This made it possible to draw and to erase vectors or other supplementary material on the plastic while discussing the problem. Projection from the front creates bothersome shadows.

The experimental work of Dean Bryans and his associates with movies for theory courses in engineering mechanics has been along two lines: (1) Short animated diagrammatic cartoons of such subjects as the counterbalance of a locomotive drive wheel (Fig. 2), development of an involute gear tooth mechanics, quick-return mechanisms, and aeronautics and (2) demonstrations of complicated laboratory experiments in photoelasticity, reciprocal displacements, and metals testing by means of black-and-white and colored motion pictures. Results obtained with this method of teaching have proved so successful that the electrical-engineering department at the University has suggested the making of short films covering some theory matter in its field.

Music While You Work

THE ENGINEER (GREAT BRITAIN)

MUSIC is being used in England, according to an article in *The Engineer*, July 12, 1940, to speed up production and to keep up the morale of factory workers in wartime. Tests have shown that the increase in production under favorable

conditions is not less than six per cent. The government is encouraging the expansion of the plan in industry, especially in plants where light work of a repetitive type is being carried out, mainly by girls, through the British Broadcasting Company, which is now sending out a series of special programs, entitled "Music While You Work."

The apparatus utilized in a typical factory usually consists of a sound-reproduction unit wired to loudspeakers placed in various spots in the plant, a phonograph for playing records, a radio to receive the B.B.C. programs, and one or more microphones to make announcements to the workers and to give air-raid warnings. In most cases, equipment of this type has been installed since the beginning of the war. To protect the controls and sound-reproduction units, these are usually found deep in the heart of an underground part of the factory.

Lentz Steam Engine

ENGINEERING AND BOILER HOUSE REVIEW (GREAT BRITAIN)

A NOVEL type of steam engine, which utilizes many features of Diesel engines, has been designed by Dr. Lentz, an Austrian engineer, according to a report in *Engineering and Boiler House Review* (Great Britain) for August, 1940. As shown in Fig. 3, admission to each of the cylinders is through valves operated from a camshaft, while the exhaust of the steam takes place through ports arranged in the cylinder in a manner similar to those in uniflow engines.

The designer claims a Rankine cycle efficiency ratio of 92 per cent and a steam consumption rate of 6.6 lb per ihp-hr. At a final steam temperature of 842 F, this figure can be further reduced to 5.5 lb per ihp-hr. Plans are being made for the mass production of two engine types, namely, a 6-cylinder type with outputs ranging from 250 to 1250 ihp, and a 9-cylinder type for 375 to 1875 ihp, both to run at speeds from 900 to 2000 rpm. Thus, unit-engine weights as low as 6.6 lb per ihp are possible. Two or more engines may be geared to a common shaft, thereby obtaining a unit developing up to 7500 ihp per shaft. One unit of this type, composed of two 1440-lb, 600-ihp engines and a 3800-lb reduction gear, will weigh 5.6 lb per ihp. A special design for use as a direct individual wheel drive on locomotives will weigh only 2.2 lb per ihp.

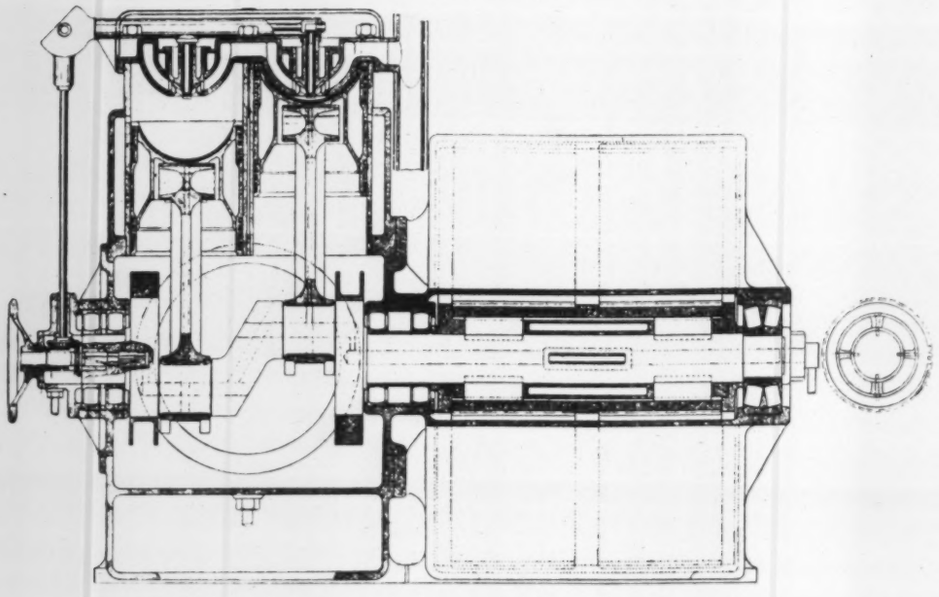


FIG. 3 DETAILS OF LENTZ STEAM ENGINE
(Longitudinal section shows flexible reduction-drive pinions while end view indicates arrangement of cylinders.)

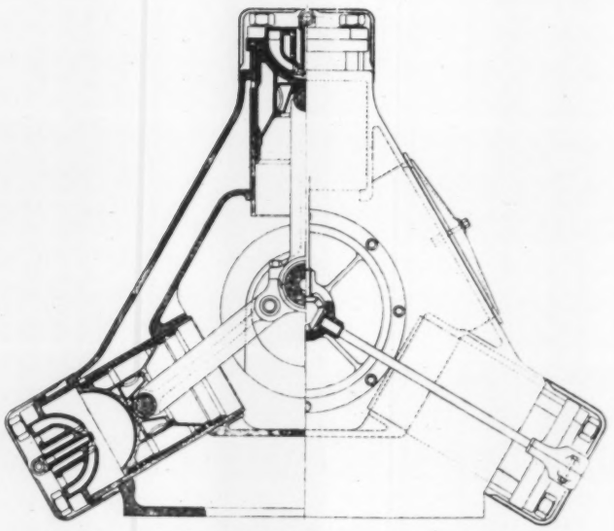


FIG. 4 CYLINDER ARRANGEMENT, LENTZ STEAM ENGINE

These engines are designed to rest directly on the condenser, thereby eliminating the need for a special foundation or base plate. The cylinder heads are steam jacketed, while the hollow pistons are evacuated. The steam-supply pipe is shielded against radiation loss by placing it into another pipe of slightly larger diameter from which the air has been removed creating a vacuum. An ample oil supply for lubricating and cooling purposes is provided.

Sugar-Cane Harvesters

FACTS ABOUT SUGAR

THE cutting of sugar cane by machinery has at last gone beyond the experimental stage and into the realm of the commercially practicable, is the statement made in an article appearing in the magazine *Facts About Sugar*, April, 1940. Two different types of sugar-cane harvesters have been developed in Louisiana as a result of independent endeavors during the last three or four years, but the one which has attracted the most attention is a machine invented by Joseph J. Munson.

The Munson machine was tried out in 1938, but 1939 was the first year in which it was used in more than an experimental way. Sometimes, the machine is referred to as the "Munson windrower," and, in fact, it is not a complete harvester, in the sense that it does not strip and load the cane, as some other more elaborate machines have been designed to do. It does, how-

ever, cut the cane with efficiency, and leaves it in rows, ready for the pilers and loaders who follow. Alternatively, it can be used to cut the cane at the bottom only, without topping it, and to deposit it in the "middles" between the rows. This operation, known as "windrowing," is extensively practiced in Louisiana, because of the ever-present danger of killing frosts during the latter weeks of the harvest season.

As described in the article, the machine, built on a steel frame that is carried on three pneumatic-tired wheels, cuts or windrows two rows of cane at a time. With a driver and two helpers, the machine in continuous operation and without any time lost in turning will take care of $1\frac{1}{2}$ acres of cane per hour. An adept cutter using a knife may account for two tons of cane per day. Since cane grows from 20 to 35 tons per acre, it is apparent that the new machine accomplishes in an hour what it formerly took one man two weeks to do.

Powered with a 30 or 40-hp tractor engine, the machine uses tractor fuel. The transmission from the engine is through a four-speed and reverse transmission to a bevel gear which drives a vertical shaft in the rear of the machine. This shaft drives through bevel gears at the top, the jackshaft, which drives the rear wheels, and a cross-shaft which is so arranged that it drives all moving parts with the exception of the cutters. The cutters, which are driven from an extension of the rear vertical shaft below the bevel-gear casing, are of the bar and sickle type.

The second machine, which has not yet attained such prominence as the Munson, is the one developed by A. R. Wurtele. His machine cuts, strips, and tops the sugar cane, loads it automatically into sugar-cane cars it hauls behind it, and changes the loaded cart for an empty one at the end of the rows. While a light tractor speeds the filled cart to the mill, the harvester starts back up the row with the empty one to repeat its performance.

The Wurtele cane combine, as it is called, weighs 3000 lb and is built on a 6000-lb standard, heavy-duty farm tractor, which burns tractor fuel. Huge wheels in the rear are equipped with balloon tires that drive through the heaviest mud more effectively than any mule. The machine operates by a power take-off from the tractor. Its circular saw is of heavy steel, hydraulically adjusted. It cuts the cane at ground level as it is drawn into line by a steel "Y." Endless chains with steel fingers carry the cane through the machine that tops, strips, and automatically loads it into the cart hauled behind the harvester. The topped nubbins are collected in a large steel box and dumped at the end of the row. These nubbins may be used as cattle feed and thereby actually pay the cost of the harvesting operation. Five men are required to operate the machine, which can cut, top, strip, and load from 15 to 20 tons of cane per hour.

Air Conditioning in the Nose

HEATING, PIPING, AND AIR CONDITIONING

THE nose is a most effective conditioner of respired air, states Lauren E. Seeley, member A.S.M.E., and assistant professor of mechanical engineering, Yale University, in an article appearing in the June, 1940, issue of *Heating, Piping and Air Conditioning*. He bases his statement on a series of tests conducted on himself as the subject in order to develop a technique for measuring what happens to the temperature and water-vapor content of respired air in the nasal cavity with various atmospheres and temperatures. There were two broad objectives in this work, namely (*a*) to aid air-conditioning engineers in their work, especially as it relates to the control of relative humidity, and (*b*) to emphasize to physiologists that man's aerial environment involves physiological consequences associated with respired air in addition to heat-loss problems associated with external or body-cooling air.

The testing of air-conditioning devices is an engineering job. So the tests to be described were strictly performance tests of an air-conditioning device, namely, the nose. Apparatus for the test included an enclosed space about 9 ft square and 7 ft high, a 5-hp air-conditioning unit for heating or cooling this space, and equipment for taking samples of air from the nasal cavity. Included with the equipment was a stainless-steel tube $\frac{1}{8}$ in. in diameter and about 5 in. long, perforated near the end to admit the air sample and equipped with a precision thermocouple near the perforations; an absorption tube containing anhydrous magnesium perchlorate; a collecting bottle with carborundum saturators; a potentiometer for measuring temperature; a graduate for collecting water; and a manometer. The sampling tube was inserted into the nasal cavity between the floor of the cavity and the inferior turbinate at four different positions ranging from almost four inches inside the nasal cavity to the portal or opening of the nose.

The tests clearly revealed that the greatest change in temperatures and water-vapor content take place in the nasal cavity. Moisture loss from the mucosa or moist skin inside the nasal cavity is influenced by relative humidity. In other words, the temperature and relative humidity of inspired air affect the moisture loss. Whatever may be the temperature and relative humidity of the air in the lungs the data obtained from the tests reveals that the outside air neither reaches nor leaves the lungs in a saturated condition. However, cold, inspired air upon passing over warm, moist skin surfaces may become temporarily supersaturated.

Since all tests were made under what were believed to be conditions of equilibrium of the body in its several environments, the contention is made that a sudden change of environment may produce an equally sudden change in the rate of nasal moisture loss. This new rate of moisture loss must ultimately be compensated for by the body if the nasal mucosa is to retain its normal, physical characteristics, i.e., surface tension, viscosity, and osmotic pressure. However, if this adjustment is not immediate, the nasal mucosa will be at least temporarily altered in physical characteristics. This in turn might permit infection if air-borne infective agencies are present in the new environment. While commonly known, it is not generally appreciated that heating and air-conditioning practices create environments which may contrast sharply with atmospheric conditions and that people pass almost instantly from, in effect, one climate to another.

The most important premise contained in the report is that the shock of a quickly altered environment can be minimized if the indoor relative humidity is controlled in such a way as to prevent any appreciable change in the rate of moisture loss from the nasal cavity. Moisture losses from the fluids discharged from the sinuses are also involved. The importance of a complete and normal mucous lining in the respiratory tract should be clearly established.

Fluorescent Carpet

FORTUNE

TODAY you can step into a darkened theater and find your way easily to a seat by "carpet light"—light that shines up out of the fabric itself, states a brief note in *Fortune* for August, 1940. The light is produced by means of a special fluorescent dye in the carpet which glows under invisible ultraviolet rays, and in no way distracts the vision from the screen.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Management and Engineering Education

COMMENT BY R. B DALE[1]

The engineering practitioner operates within the realm of economic activity. He is constantly surrounded and personally engaged in such human activities as money-making, profit-seeking, competitive markets, the standard of living, and moral and social objectives of the people. Dr. Hotchkiss[2] has made out a good case for the inclusion of industrial management subjects, at least to a minimum degree, in the curriculum for all engineering students. In view of the fact that the engineer lives and breathes in an atmosphere of business activity and commercial relations, no one can deny that engineering education, if it is to continue to meet its obligations to contemporaneous living, must needs provide a competent program in industrial management.

Also, engineers will agree with Dr. Hotchkiss when he calls for a carefully considered balance between engineering subjects and management subjects, and a well-adjusted grouping among the management subjects themselves. Surely, due place must be given to economics in such programs. The question is immediately raised: What kind of economics? If this commentator may be permitted to answer, he would suggest that realism be emphasized. Economics is so predominating a factor in the thoughts and actions of all people, that it appeals to most engineers as a pragmatic rather than a theoretic subject.

In the group of management subjects, shall we include industrial organization and management? This subject seems to be a fundamental introduction to a study of the corporate structure and its operations.

Certainly, these two subjects, economics, and industrial organization and management, might be regarded as the absolute minimum for all engineering students—no less.

This commentator would include in the minimum program: Statistical method, with emphasis on quality control; social and economic tendencies, a topical study in contemporary social and economic problems; industrial psychology, principally objective psychology, but subjective to the point of practical considerations in getting and holding a job, and personal development for leadership; industrial marketing, sales methods in distributing industrial goods and products; and financial management of industry, with emphasis on internal finance including cost accounting and budgetary control. This for all students in all engineering courses but, of course, as Dr. Hotchkiss points out, these subjects, while accorded thorough treatment, should not, and in fact cannot, be unduly expanded.

Dr. Hotchkiss places emphasis on the objectives of *competence* and *leadership*. Those who have had experience with such a program will agree that it is remarkably effective in attaining these objectives.

More simply stated, the program is both formative and informational. It opens the engineering students' minds. It establishes attitudes. It offers an experience of utmost significance for the young engineer.

Dr. Hotchkiss points out that "more than half of the engineering graduates who have reached the age of forty have positions that carry important management responsibility..." It is also true that a rapidly increasing number of recent graduates secure their first employment in positions which require an interest in and knowledge of production control, cost systems, time and motion economy, inspection and quality control, materials and operations flow, factory and machine layout, and the like, all leading directly to the broader aspects of industrial management. More and more young engineers are beginning to have an understanding of the corporate income statement and the balance sheet.

Industrial-management subjects are demanding and holding a place for themselves in the engineering curriculum on their merit. This is true, even though there is the keenest competition for places for essential engineering subjects in a four-year curriculum already overcrowded with many of the obligations and responsibilities which might well be more generally and more adequately assumed by the high schools.

COMMENT BY CARROLL D. BILLMYER[3]

Both author and editor deserve commendation for the excellent paper by Willard E. Hotchkiss. The writer enjoyed the paper not only because it is the most temperate and unbiased exposition of the subject he has seen; but because his own industrial experience leads him to believe it remains a very vital subject for the scrutiny of engineering educators. At all times the instructor is confronted with the choice of teaching the subject matter in which he is most interested and best informed or of teaching those things which are of most value to the student and the economic system of which he is a part.

In the period immediately following World War I, such undue emphasis was placed on the attributes "aggressive personality," "executive ability," and so on, that laymen could not be blamed for inferring that technical knowledge and the ability to think were not requisites for the executive. Consequently, one frequently spent much of his time combating impractical or impossible ideas planted in the mind of his superior by those who knew no better. The writer knew many who were unable to form unaided an opinion as to the completion of the orders they so confidently gave. They also knew or cared very little about labor's problems. He has seen many strikes due to this cause.

To remedy such a situation, some advocate a curriculum containing a minimum of technical work, with an abundance of management work, particular emphasis being placed on management techniques. The author very aptly describes the dangers of such overexpansion of management courses.

It would seem far better to include management subjects in an engineering course with little specialization during the four years. We would then furnish industry with men fundamentally trained, who could be adapted to meet its chang-

[1] Head of Department of Industrial Management and Mechanical Engineering, School of Science and Technology, Pratt Institute, Brooklyn, N. Y. Mem. A.S.M.E.

[2] "Management and Engineering Education," by Willard E. Hotchkiss, MECHANICAL ENGINEERING, August, 1940, pp. 605–608.

[3] Assistant Professor of Mechanical Engineering, Rhode Island State College, Kingston, R. I. Mem. A.S.M.E.

ing requirements. For such a purpose, the author states "the objectives of management study in a college of engineering are to lay foundations for competence and leadership; its scope must be as broad as management itself.....Balanced judgment in doing this and appraising results of analysis in specialized fields may easily be warped when the manager is a master in one of these fields."

Like many other subjects, the field of management is now covered by an ever-expanding list of books and periodicals with which the young engineer can supplement his academic training. Our experience with such a course here, given for the last ten years, indicates that those men getting into managerial work are able to do the required self-study. Reports from employers indicate their satisfaction with the results obtained. In the larger cities, the courses sponsored by the E.C.P.D. and meetings held by the local sections furnish further incentive for such self-study.

When the mechanical engineer graduates, he may go into production, sales, design, or research in connection with many varied lines of endeavor. Certainly not at matriculation and very seldom at graduation, does he know which specialty he will follow. If this is so often the case, are we justified in too much specialization, either in engineering or management, during the undergraduate years?

Clarification of Fellow Grade

TO THE EDITOR:

The clarification (?) of the Fellow grade of membership, published in the September issue of MECHANICAL ENGINEERING, throws the spotlight on an incongruity which borders on the absurd.

A Fellow must be "an engineer who shall have distinct engineering attainments," and a member desiring to become a Fellow "shall make application to the Council on an approved form."

Imagine a man with any sense of propriety and with even rudimentary modesty "making application" to be elected a distinguished engineer ! !

Whether or not a man is "distinguished" in any activity is determined by others—not by himself, and it ill becomes him to suggest it of himself; indeed, if he is entitled to be so regarded it will not be necessary that he do so.

If one must make application for admission to the Fellow grade the specified requirements should be so clear-cut that the applicant may judge in advance whether he is qualified. The decision of the Council would then be based on a factual record which could be compared, point by point, with definite specifications, and not on interpretations of such vague expressions as "distinct engineering attainments," "professional man of full stature," and other meaningless phrases which may be expanded on occasion to the tenuity of the stratosphere or condensed at will to small volume. The caution that "care should be taken not to award too many Fellow memberships" suggests that such interpretations may be, like the volume of a gas, a function of the pressure.

If, on the other hand, the Fellow grade is to be limited to really distinguished engineers, then action should be taken by the Council either on its own initiative or after consideration of petitions signed by a specified number of members. If this is not done the time will come when the Fellow grade will be composed—not of the most distinguished engineers, but of those with the most unmitigated effrontery. Few who should be in that grade will ever make application.

CHARLES W. COMSTOCK.[4]

Unionization of Engineers

TO THE EDITOR:

Members who read the discussion of unionization[5] by Mr. Herron and others must have been struck by the frequent reference to the word "professional" in its various forms. In 25 letters it occurs 170 times. Judging from the context, the engineer-writers have great independence and originality in applying this term to the several aspects of their occupation.

One writer implies that he is "professional;" but that all those of certain degrees of lesser attainment are "subprofessional;" another that the word covers ethical factors only; yet another that consulting engineers are the Simon-pure professionals; and one denies that his calling is a profession at all. It would seem that the professional engineer is distinguished from his fellow engineers and fellow citizens by a vague group of factors taken singly or in multiple—engineering education, ability, independent practice, state license, society membership, prominence, ideals, ethics, age, or what-have-you.

In this uneasy sea of semantics, I was lost until I clutched desperately at my old friend Webster, and found some solid ground. Webster says:

Professional. Of or pertaining to a profession, or calling; conforming to the rules or standards of a profession; following a profession, or some line of conduct as if it were a profession.

Profession. 3. That of which one professes knowledge; the occupation, if not purely commercial, mechanical, agricultural, or the like, to which one devotes one's self; a calling in which one professes to have acquired some special knowledge used by way of instructing, guiding, or advising others or of serving them in some art, calling, vocation, employment, as the *profession* of arms, the *profession* of chemist.

"Professional" may continue to be a joker-wild in descriptive terminology for others, but for me, it means henceforth what Webster says it means: *Special knowledge of, and devotion to one's occupation.* No reference to scholastic degree, or to title, or to license, or to private practice, or to length of whiskers. We note particularly that it has concern with a man's attitude toward his occupation, and not with his material return from it. It is a product of his mind and of his heart, and is not a measure of economic status.

Applied to engineering, this definition makes it plain that for most men in that line engineering is a profession. Except for those few inevitable incompetents who squeezed in, I have known no engineers who were not professional. The lowly draftsman on the last table, provided he is reasonably competent and devotes his best to his work, is just as "professional" as the consultant with an international reputation.

Is the A.S.M.E. professional? I am sure that its founders so intended. Its strength lies in the professional standing and accomplishments of its members. It would be stronger if it made possible the membership of the thousands of engineers professional by the standards as just cited, but erroneously and too contemptuously referred to by certain members as "subprofessionals" and "technologists."

Certain activities, handled directly or sponsored in part by the A.S.M.E., have not been wholly professional. The Committee on Economic Status of the Engineer seems to be concerned chiefly with the restricted subject of fees for consultants. The employment service exacts service charges for employee members, but gives free service to employer members. The "Index," fundamentally a professional function of such a society, has been diverted into a commercial affair available only to plutocratic members and research organizations. Our membership is largely in two economic groups, the one primarily of employers, the other of employed members. They meet on the good common ground of professional interest. Beyond that, their

[4] Jackson Heights, N. Y. Mem. A.S.M.E.

[5] "Unionization of Engineers," by James H. Herron, MECHANICAL ENGINEERING, vol. 61, November, 1939, pp. 788–789 and 822. Comments will be found in January to July, 1940, issues, inclusive.

economic interests divide sharply. Those society activities which are economic, and specifically those which favor one of these groups at the expense of the other, are bound to be sources of weakness.

Finally, how about unionization? Well, that is another strictly economic question. It relates to what one gets from his occupation. It is not a professional matter, concerned with his special knowledge and his devotion to his work. If the A.S.M.E. is, or aspires to be, a truly professional society, the merits of unions are entirely outside its scope; it has no authority to pass judgment on them.

Union organization is an economic device wholly apart from the A.S.M.E., and membership in a union is a matter to be decided solely by those interested. I am confident that the engineer, young or old, who finds that he must meet one of his economic problems that way, will retain his professional instinct, and will bring to such an organization the same high standard of conduct and performance that he brings to his other affiliations.

I submit that the A.S.M.E. is not qualified, due to the diverse economic interests of its members, and to its professional basis, to pass on unionization; further, that as members we should not permit the A.S.M.E. to be used as a stalking horse by those who seek either to condemn or to encourage such organization.

ORWELL LOGAN.[6]

TO THE EDITOR:

The following is quoted from A. G. Christie's article, "Engineering-Society Life of the Young Engineer," appearing in the February, 1940, issue of MECHANICAL ENGINEERING:

> The problem of proper remuneration for engineers is a difficult one. Attempts have been made to fix salary scales, but these have not been universally accepted. Economic conditions and competition for jobs in various sections of the country are disturbing factors. Finally, depressions tend to upset established rates, as cuts in salary are common at such times. It is a fact that the average pay of the young engineer when starting his industrial career is low in comparison to trained mechanics and laborers. This condition needs consideration and correction.
>
> Clearly, our national societies must give more thought to this question of remuneration for the members of its professional group. Otherwise, some labor-union organization will preempt this function to the detriment of the national society and of engineers themselves.

If one had to start out at a very low rate of pay and would be advanced from the very low starting wage in proportion to his ability to earn, I, for one, would not complain. But it would seem that the young engineer has a much greater obstacle in the way of financial advancement than this—the attempt of far too many concerns to keep the young engineer on and on at little, if any, more than the rate he started in at, on a beautiful mirage of promises, which, in too many cases, so it would seem, were never intended to be fulfilled when made. This condition must be worse than ever now with so many engineering graduates, more by far than there are openings for them, so that it is easier than ever before for the employer to take unfair advantage.

Here is where it seems to me the engineering societies, both national and local, can be of help. Where it appears certain beyond any reasonable doubt that the employer is "short changing" the young member, the societies ought, it seems to me, to make every effort possible in helping him secure a better location. They ought to stand back of him 100 per cent when he is in the right. Perhaps if the young members of the various societies were requested to turn in the amount of their earnings for the first few years, this information ought to assist them in determining cases where the young member is being underpaid. Local sections of national societies ought, too, to be helpful in solving the problem in question, or in helping to solve it.

Employers should remember that "a man ought to be willing to pay for what he gets, and the man who wants two dollars worth of work for one dollar is not an honest man."

As for the employer who will not advance the young engineer in proportion to his ability to earn, there is no use in the young member going out of his way to do a lot of extra things, or to do more work than this kind of an employer is willing to pay for. To do extra work for such an employer will gain no additional remuneration, in fact, the more that is done, the more will be expected to be done. To do more than the minimum for such an employer lowers the standard of pay for the young engineer further than ever, and makes it just that much more difficult for all in the employ of such a company to make a living wage; it still further encourages the employer to keep on being dishonest. Here is where the societies can take the young member's part and assist him in getting what pay is coming to him. In such a case a change in location should be made if at all possible; no one can be really interested or do his best when working for dishonest people.

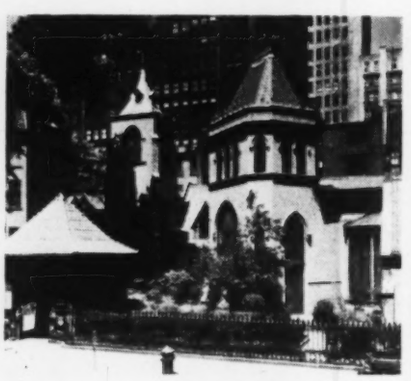
The various societies should do all possible to prevent concerns and corporations agreeing with one another *not* to hire engineers in the employ of another company. Such employers should not stand in the way of advancement of engineers, and it is hoped the various engineering societies can be of help in breaking up such "pressure groups" when they interfere with the just rights of the engineer.

One reason for objecting to a union, on the other hand, is the tendency of the president or head of the union to be a dictator over the union. I hope sometime a national law will require all unions to hold each year an election of all officers, so that the members of the union can vote in the head the majority of voters want.

I believe engineering societies can be a far greater force in American life than they ever have been. Can they not be somewhat of a watchdog over the affairs of our country—one whose recommendations all our citizens and voters can have confidence in, if only great care is used in selecting the proper society officials—as well as assisting in obtaining proper remuneration for service rendered by their members?

In attempting to accomplish these things, it seems to me our societies should by all means take the course which makes for liberty and free men, and go directly opposite to the regimentation scheme so prevalent in our country now. It is my contention that it is not possible to have a truly great civilization without honesty, without intelligence, and without liberty. All of us should remember that "Liberty sustains the same relation to all the virtues that the sun does to life."

JOHN M. WOOD.[7]



THE LITTLE CHURCH AROUND THE CORNER, NEW YORK CITY

(A.S.M.E. Annual Meeting, New York, N. Y., Dec. 2–6, 1940. See pages 847–854)

[6] Berkeley, Calif. Mem. A.S.M.E.

[7] Albany, Wis. Mem. A.S.M.E.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Autobiography of an Engineer

AUTOBIOGRAPHY OF AN ENGINEER. By W. L. R. Emmet. The American Society of Mechanical Engineers, New York, N. Y., 1940. Cloth, 6 × 8¾ in., 233 pages, $3.50; to A.S.M.E. members, $2.80.

REVIEWED BY A. R. STEVENSON, JR.[1]

IN 1931 this autobiography was privately published. It was read with joy and interest by a great many of those who loved and admired Mr. Emmet. It was felt by his friends that such a sincere and clear picture of the life of a famous engineer would be of great interest, benefit, and a stimulus to young men planning to enter the engineering profession. It was, therefore, included in the list of recommended reading prepared by the Engineers' Council for Professional Development.

The first edition was unfortunately completely exhausted by the time the list was circulated. Thereupon, Mr. Emmet's friends undertook to persuade him to republish it.

It is a pleasure to announce that a new and enlarged edition has now been published by The American Society of Mechanical Engineers as one of their series of lives of famous mechanical engineers.

The book is of fascinating human interest giving a personal insight into the trials, tribulations, and successes of a great engineer. It is well worth the price and will be of great value, interest, and stimulation to any young engineer.

Mr. Emmet's adventures as a young man, his life at the Naval Academy and at sea, and his adventures as a young construction man in the early days of the electrical industry are fascinating.

Mr. Emmet arrived in Allegheny, Pa., to install a trolley line. He realized from previous experience that there would be many motors burned out due to the splashing of water on the poor insulation. He decided to tear the motors all apart and completely rewind them according to a new design of his own which incidentally included varnished cambric insulation which later became almost universal. Although he was only a fifteen-dollar-a-week construction man he took this responsibility knowing "that Nelson and others did not always obey orders and that some disobedience was all right for those who could get away with it successfully."

It was all done in direct disobedience of orders and at the risk of very serious consequences to me in the event of even partial failure, and was based upon the confidence which came from careful and thorough thinking. It was work of a new kind and of a degree of merit in the matter of insulation which had never been approached in the electrical industry and it bore the seeds of radical improvements which I introduced on a large scale later. . . .At the end of six months I got a check for every dollar due to my employers, and the owners were greatly pleased by the success of the road. While all this was going on these same motors were giving as much trouble in Boston, Cleveland, St. Louis, and elsewhere . . . . and a large part of their selling price was never collected.

A few additional quotations may be of interest:

Manners, a very important thing for anyone to know who is going to be crowded into ships with other men.

Inferior men in executive positions can be depended upon to surround themselves with people of their own caliber or worse.

The more a man originates and tends to depart from the beaten path the more he has to exert himself in selling his product.

In large constructions of new types much of the selling must be done by engineers who have positive conviction as to reasons. Uninformed people cannot inspire the necessary confidence.

It is far more easy for the government to scrutinize the doings of one large concern than many small ones and wrong doing by large concerns is for many reasons difficult and unsafe.

There is another merit in large concerns. They have to be more honest and broad in their policies than small ones. They are too big and complicated to be adroit and nothing but the broadest policy of plain dealing is in the long run found to pay.

With all we hear about crime an extremely small fraction of the human race is inherently criminal.

In large concerns as in small, a man's success depends upon his will power and upon the confidence which he inspires in his associates... There are petty tyrannies in all industry but fewer of them in big industry than in small.

The hope of future generations lies in the evolution of a race which has judgment, foresight, and providence, and we cannot hope to produce it by giving people the sheltered life . . . . such kindness should be rather a matter of personal judgment than of governmental policy.

Another matter of dominant importance which the engineering leader must bring about is experimentation.

The only way to get new things done is to do them . . . .It is generally fruitless to simply suggest them to other people.

There are many other similar gems which indicate the rugged optimistic philosophy of the author and which might well be taken to heart as maxims by the younger reader.

Young people get ideas with regard to various professions from the multitude of novels and biographies which are available. The life of a soldier helping to build the British Empire has been described in the novels of G. A. Henty and in the works of Rudyard Kipling, Winston Churchill, and others. There have also been novels and biographies describing the lives of lawyers, newspaper editors, politicians, scientists, etc. There have been both biographies and books describing the works of civil engineers, highway engineers, and shipbuilders, but books which would give a young man a picture of what an electrical or mechanical engineer might do in industry are all too few.

Mr. Emmet's tremendous value to industry has best been described by E. W. Rice, one of the founders and former president of the General Electric Company.

During his forty-five years of activity Mr. Emmet has had a leading part in at least four important phases of electrical development. The first embraced contributions to many types of apparatus and methods of distribution which have been extensively used for many years in the central-station electric industry.

The second covered steam-turbine electric apparatus, which largely through his designs and tireless energy was within a few years brought from small beginnings to a place of dominating importance in the electrical industry.

His third related to the electrical propulsion of ships, and this was a long difficult task. It was fitting that his first successful demonstration of the value of this method of propulsion was made in its application to ships of the United States Navy. It is my belief that the Navy owes a great debt to the persevering

[1] Staff Assistant to Vice-President in charge of engineering, General Electric Co., Schenectady, N. Y. Mem. A.S.M.E.

efforts, as well as the technical skill, of Mr. Emmet. The same system is now being adopted by a number of large merchant vessels.

Mr. Emmet's fourth, and most difficult and prolonged, task has been the invention, design, and development of the mercury-vapor power system which makes possible the production of some thirty per cent more power from coal than has ever before been accomplished.

Mr. Emmet has written an autobiography of himself in a sincere, straightforward manner and gives a complete picture of a man and his work, in which no attempt has been made to hide defects. The humorous anecdotes about his absent-mindedness and other personal characteristics bring out the high lights more intensively and make the whole vivid and interesting.

The writer of this book review has lived a few doors from Mr. Emmet during his whole life and has, therefore, grown up under the spell of his outstanding and lovable personality, and can testify to the love and admiration which the men in the General Electric have for "Uncle Bill Emmet."

Mr. Emmet's career is very interesting from an educational standpoint. He was at the bottom of the class at Annapolis. A recent paper by a Massachusetts Institute of Technology professor[2] shows a table indicating the large percentage of famous M.I.T. graduates who were in the bottom tenth of their classes and asks the question, "Is a poor school record sometimes the very result of creative ability? May not a restless appetite for reaching out toward the far horizon make the predigested food of most college courses somewhat nauseating? Certainly these men didn't achieve distinction just because they were at the bottom of the class."

It has also been pointed out that the outstanding designer of new things has a creative ability somewhat similar to the creative ability of artists who paint great pictures, musicians who write great music, authors who write great pieces of literature. Mr. Emmet comes from an artistic family that has painted pictures, written literature, taken active part in political reforms, and this from an inheritance standpoint may account for his creative ability in engineering.

He is an all around man with a love for music, good books, and an intense interest in sports, such as golf, curling, fishing, and boating.

It has been said that the successful engineer must have three abilities: First, to select worth-while problems; second, to solve these problems; and third, to sell the solution. Mr. Emmet has been outstanding in all three of these fields. His life tends to illustrate how much more important this third phase of selling the solution is than any young engineer might imagine. All in all, this book is an adventure story of achievements in real life of more dramatic interest than most novels.

[2] "The Selection of Men With Creative Ability," by F. Alexander Magoun, MECHANICAL ENGINEERING, September, 1940, pages 670–672.

The Story of Flying

THE STORY OF FLYING. By Archibald Black. Whittlesey House, McGraw-Hill Book Co., Inc., New York, N. Y., 1940. Cloth, 6 × 9 in., 267 pp., 66 figs., $2.75.

REVIEWED BY JEROME LEDERER[3]

THE Story of Flying moves with the speed of flight through the history of aviation, landing only at points of historic or significant importance. Dreary or monotonous intervals are not part of the flight plan. The velocity with which the story moves, combined with a narrative style and some interesting old photographs, gives considerable zest to the story, even to one who might already be familiar with much of the contents. To newcomers in aviation, seeking material to build up their aviation background, it is a "must."

The book is of peculiar interest when associated with aircraft activities in Europe today. For instance, the first crossing of the English Channel by air took place in 1785, the first use of balloons for observation in warfare was in 1784; the first successful parachute descent by man occurred in 1797. All this was accomplished by Frenchmen following the development of the first successful balloon by two other Frenchmen, the Montgolfier brothers. Bleriot, another Frenchman, made the first crossing of the Channel in powered flight and "Europe was hysterical with excitement."

Turning back a few pages we read that de Lana, a seventeenth century Frenchman, invented the vacuum balloon but "did not follow up his experiment for an amazing reason—he had become alarmed at the possible consequences that might follow its perfection. He envisioned the destruction of cities, ships, and even by the dropping of incendiary balls of fire from the skies!"

From da Vinci, Roger Bacon, de Lana, right up to studies made by the engineering staffs of large manufacturers in 1940, the book presents a fine perspective of technical developments and their cumulative relationship toward more successful flight. It is thought-provoking to be reminded that da Vinci built the first model helicopter that flew, that Stringfellow effected the first true powered flight of a model airplane as early as 1848, that Sir Hiram Maxim in 1893 built an airplane 5500 sq ft in area, which developed so much lift in its first flight that it carried away the guard rail which was intended to keep it from making a free flight. His steam engine, which developed 360 hp, was more powerful than any aircraft engine subsequently built until about the middle of the World War.

The work of Langley, the Lilienthal brothers, Chanute, and Manly leading up to the first flight by the Wright brothers, as written by Mr. Black, emphasizes the care and attention to detail which has always marked successful ventures in aviation.

The growth of scheduled air transportation (the first scheduled air line was operated by Zeppelin service in Germany in 1911 and continued to the outbreak of the World War in 1914), the transition of "gypsy" pilots into fixed base operators (who are now basic factors in the civil pilot training program), and all significant postwar developments are included.

In the light of current history in this country the chapter "The World Goes to War" shows a remarkable resemblance between 1917 and 1940, especially in connection with the production of airplanes or engines and the relation of automobile manufacturers thereto.

For old timers and newcomers alike the book should be most interesting, but to the newcomer in particular the reading of this book should prove an interesting way to absorb aviation background.

[3] Director, Air Safety Bureau, Civil Aeronautics Board, Washington, D. C. Mem. A.S.M.E.

A Romance of Industrial Engineering

REVIEWED BY HOWARD S. BEAN[4]

A ROMANCE OF INDUSTRIAL ENGINEERING. By James A. Morris. Glenfield and Kennedy, Limited, Kilmarnock, Scotland, 1939. Cloth, 7¼ × 9½ in., 149 pp., illus., 15/6.

A fascinating account of the inception and growth to what is now one of the outstanding industrial-engineering firms of the world, Glenfield and Kennedy, Limited. In tracing this growth from the invention of the Kennedy water meter and the formation of the syndicate to the present firm with world-wide activities, Mr. Morris has skillfully interwoven excerpts from minute book and diary, town records, and the recollections of men who

[4] Senior Physicist, Chief, Gas Measuring Instruments Section, National Bureau of Standards, Washington, D. C. Mem. A.S.M.E.

were with the company in its "middle era," so as to bring out the romance in the growth of an industry. In addition there are throughout the book numerous paragraphs about the town and townfolk of Kilmarnock, Scotland, during the middle of the nineteenth century which are particularly interesting to one with a justifiable pride in Scotch ancestry, even at a distance of three centuries.

Books Received in Library

APPLIED X-RAYS. By G. L. Clark. Third edition. McGraw-Hill Book Co., Inc., New York, N. Y., 1940. Cloth, 6 × 9 in., 674 pp., illus., diagrams, charts, tables, $6. This book is intended for the industrial executive who wishes to know what X rays are, how they may be used, and the ways in which they can be applied to practical industrial problems. The first section discusses the general physics and applications of X radiation, the second covers the analysis of the ultimate structures of materials. The book has been completely rewritten in consideration of the great advances since the previous edition.

CALCULATION OF HEAT TRANSMISSION. By M. Fishenden and O. A. Saunders. Great Britain, Dept. of Scientific and Industrial Research. His Majesty's Stationery Office, London, England. Paper, 6 × 10 in., 7s 6d; obtainable from British Library of Information, New York, N. Y., $2.15. A large amount of published material on the transmission of heat has been critically analyzed and is presented here for practical use. Heat-transfer coefficients are given for a wide range of conditions, and the application of specific information to certain simple cases is illustrated. Original sources are listed in a large bibliography.

COAL, Its Properties, Analysis, Classification, Geology, Extraction, Uses, and Distribution. By E. S. Moore. Second edition. John Wiley & Sons, Inc., New York, N. Y., 1940. Cloth, 6 × 9½ in., 473 pp., illus., diagrams, charts, tables, $6. In a single volume, Dr. Moore provides a comprehensive summary of our knowledge of coal. Physical and chemical properties, classification, origin, structural features, mining, preparation, and uses are discussed with sufficient detail for the average reader. The coal deposits of the world are also described. This edition has been thoroughly revised and new material added.

DETAILED PROOF OF THE CHI-SQUARE TEST OF GOODNESS OF FIT. (The Harvard Phi Beta Kappa Prize Essay for 1939.) By E. R. Greenhood, Jr. Harvard University Press, Cambridge, Mass., 1940. Cloth, 4½ × 7 in., 61 pp., diagrams, charts, $1.25. The chi-square curve, a specific-frequency curve, is derived from considerations of the chi-square test of goodness of fit in order to demonstrate the validity of the use of the curve in the test. Limitations in the application of the test are discussed.

DEUTSCHE AKADEMIE DER LUFTFAHRTFORSCHUNG, SCHRIFTEN. Hefte 11, 13, and 14. R. Oldenbourg, Munich, Germany, 1939-1940. Paper, 7 × 10 in., illus., diagrams, charts, tables. Heft 11, Zur Sauerstoffbestimmung auf physikalischem Wege, by H. Rein. 7 pp., 0.50 rm.; heft 13, Biologische Probleme des Hochgeschwindigkeitsfluges, by S. Ruff. 22 pp., 1.40 rm.; heft 14, Das Widerstandsproblem der Flugmotorenkühlung, by H. Helmbold. 14 pp., 0.90 rm. These three German aeronautical-research papers discuss the following topics: (11) Physical methods for oxygen determination; (13) biological problems in connection with high-speed flight; (14) the problem of resistance in airplane-engine cooling.

ELEMENTS OF UTILITY RATE DETERMINATION. By J. M. Bryant and R. R. Herrmann. McGraw-Hill Book Co., Inc., New York, N. Y., 1940. Cloth, 6 × 9½ in., 464 pp., charts, tables, $4.50. The purpose of this book is to cover the field of public-utility rate determination, service, and discrimination from the viewpoint of the engineer and manager rather than from that of the lawyer or economist. The authors discuss reasons for the regulation of utility rates, describe the methods used to accomplish such regulation, and outline the practical limitations involved. Reference is made to many actual cases.

GENERAL ENGINEERING HANDBOOK, edited by C. E. O'Rourke. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., 1940. Flexible leather, 5½ × 8½ in., 1120 pp., illus., diagrams, charts, tables, $4. The purpose of this reference book is to present in one volume the fundamental data relating to all branches of engineering. The data are arranged in nineteen sections: Mathematics; mathematical tables; physical tables; engineering materials; theoretical mechanics; hydraulics; structural theory and design; plain and reinforced concrete; foundations; topographical and geodetic surveying; route surveying and earthwork; highways; municipal sanitation; machine elements; pumps, compressors, and hydraulic turbines; engineering thermodynamics; heating and air conditioning; fundamentals of electrical engineering; electrical measurements. This edition has been thoroughly revised and rearranged.

MECHANISM AND THE KINEMATICS OF MACHINES. By W. Steeds. Longmans, Green & Co., London, England, New York, N. Y., and Toronto, Canada, 1940. Cloth, 5½ × 9 in., 319 pp., diagrams, charts, tables; 18s; $5. As a practical aid in the study of mechanisms as mechanical contrivances the author treats only of the kinematics of machines, omitting statics and dynamics. Specific mechanisms considered include straight-line actions, gearing, belts and chains, variable-speed gears, cams, universal joints, and ratchets. Exercises accompany each chapter.

PHENOMENA AT THE TEMPERATURE OF LIQUID HELIUM. (American Chemical Society Monograph Series No. 83.) By E. F. Burton, H. G. Smith, and J. O. Wilhelm. Reinhold Publishing Corporation, New York, N. Y., 1940. Cloth, 6 × 9½ in., 362 pp., diagrams, charts, tables, $6. The beginning chapters briefly describe liquefaction methods, the measurement of temperature, and the physical properties of liquid and solid helium. The following chapters discuss superconductivity, specific heats at low temperatures, paramagnetism, temperatures below 1 deg K, the nature of the superconducting state, and the λ transformation in liquid helium. Each chapter has a large bibliography.

PRACTICAL MICROSCOPICAL METALLOGRAPHY. By R. H. Greaves and H. Wrighton. Third edition, revised and enlarged. D. Van Nostrand Co., New York, N. Y., 1940. Cloth, 6 × 9½ in., 272 pp., illus., diagrams, charts, tables, $6.50. This book is concerned with methods for examining metals and alloys with the aid of the microscope, and with the results of such investigations. A set of typical photomicrographs is presented, suitably annotated and accompanied by a concise account of the results of metallographic researches and other investigations, in so far as they afford an interpretation of the structures observed in commercial materials.

RECORDS AND RESEARCH IN ENGINEERING AND INDUSTRIAL SCIENCE, a Guide to the Production, Extraction, Integrating, Storekeeping, Circulation, and Translation of Technical Knowledge. By J. E. Holmstrom. Chapman & Hall, London, 1940. Cloth, 5½ × 9 in., 302 pp., diagrams, charts, tables, 15s. The author first discusses the nature and methods of technical science and its practical applications. This is followed by descriptions of the character, objects, and activities of experimental and technical organizations and societies. The succeeding chapters cover the various ways of searching technical literature, methods of indexing and filing, the expression and transmission of ideas, and the translation of foreign languages, with considerable reference to the author's personal experience. The qualifications and opportunities of the technician are also discussed.

A.S.M.E. BOILER CODE

Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from anyone interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Com-

mittee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-23 REVISED

P-23. Thickness of Steam Piping. (*a*) For inspection purposes the minimum thickness of pipe wall to be used for piping at different pressures and for temperatures not exceeding those given for the various materials given in Table P-6 shall be determined by the formulas given below:

$$t_m = \frac{PD}{2S} + C \quad \ldots\ldots [1]$$

where t_m = minimum pipe wall thickness in in.[1] The minimum thickness used in the formulas shall in no case be more than the minimum thickness resulting from the application of the tolerances given in any Code specification for pipe or tube material which is used for piping.

P = maximum internal service pressure, in lb per sq in. gage at the operating metal temperature for which the value of S is taken from Table P-6.[2]

For steam piping connected to the boiler drum or superheater inlet header, the value of P shall be not less than the lowest pressure at which any drum safety valve is set to blow.

For piping connected to the superheater outlet, the value of P shall be not less than the lowest pressure at which any safety valve on the superheater is set to blow.

The value of P in the formula shall not be taken at less than 125 for any condition of service or material.

D = outside diameter of pipe in in.

S = allowable stress in material due to internal pressure at the operating temperature in lb per sq in. (see Table P-6).[3]

C = allowance for threading, mechanical strength, and/or corrosion in in.

If the nominal pipe size is 4 in. or greater, and the minimum thickness of the pipe is equal to or greater than 10 per cent of the inside diameter of the pipe, the allowable pressure may be determined from the formula

$$P = S\frac{(K^2 - 1)}{(K^2 + 1)} \quad \ldots\ldots [2]$$

where $K = \frac{D}{D_1}$ or ratio of outside diameter to inside diameter, and

D_1 = inside diameter = $D - 2(t_m - C)$

or

$$t_m = \frac{D}{2}\left(1 - \sqrt{\frac{S - P}{S + P}}\right) + C \quad \ldots\ldots [3]$$

Values of $\frac{K^2 - 1}{K^2 + 1}$ for given values of K may be obtained from Fig. P-6$^1/_2$.

The symbols have the same definition as in formula [1].

(*b*) The value of C used in the formula shall be not less than that given for the respective materials in the following list:

Type of pipe ..... value of C in in.[4]
Threaded steel, wrought iron pipe
$^3/_8$ in. and smaller 0.05
$^1/_2$ in. and larger ..... depth of thread "h"[5]
Plain end steel, wrought iron pipe or tubes for 1 in. size and smaller[6] 0.05
Plain end steel, wrought iron pipe or tubes for sizes above 1 in.[6] 0.065

(*c*) The value of S in the formula shall not exceed that given in Table P-6 for the respective material and temperature contemplated, but when the temperature differs from that given in the Table, S may be determined by interpolation.

(*d*) Steel or wrought-iron pipe lighter than standard or Schedule 40 of American Standard for wrought-iron and steel pipe (ASA B36.10) shall not be threaded.

(*e*) (1) While the thickness given by the formula is theoretically ample to take care of both bursting pressure and material removed in threading, when steel pipe is threaded and used for steam pressures of 250 lb per sq in. and over, or for piping under pressure in excess of 125 lb per sq in. with water temperature of 220 F and over, it shall be seamless of a quality at least equal to Specification S-17 or S-18 and of a weight at least equal to Schedule 80 of ASA B36 in order to furnish added mechanical strength.

(2) Where threaded wrought-iron pipe or threaded brass or copper pipe is used for these services and pressure-temperature conditions, it shall be in accordance with pressure and temperature classification permitted for these materials by other paragraphs of the Code and shall have a wall thickness at least equal to that required for steel pipe of a corresponding nominal size.

(*f*) Variations in Pressure and Temperature. (1) Piping systems shall be considered safe for operation if the maximum sustained pressure and temperature on any part do not exceed the pressure and temperature allowed by the Code for all component parts of the system. It is recognized that occasional departures from the nominal operating pressure and temperature inevitably occur and therefore the piping system shall also be considered safe for occasional operation for short periods at higher pressures and temperatures.

(2) Either pressure or temperature, or both, may exceed the nominal values if the corresponding stress in the pipe wall calculated by the formulas does not exceed the S value allowable for the actual expected temperature by more than the following allowances for the periods of duration indicated:

(*A*) Up to 15 per cent increase above the S value during 10 per cent of the operating period;

(*B*) Up to 20 per cent increase of the S value during 1 per cent of the operating period.

(*g*) When a steel or wrought-iron pipe is pierced with tube holes, the maximum allowable stress in the ligaments in lb per sq in. shall not exceed the values given in Table P-9 and the maximum allowable pressure shall be computed in accordance with the rule in Par. P-180 provided the tube holes do not pierce the weld in the welded pipe and provided the pressure shall be not greater than that allowed for the unpierced pipe.

(*h*) In determining the thickness to be used for brass or copper pipes at different pressures and temperatures, use the formula and the values of S given in Par. P-26 subject to the restrictions of (*d*).

(*i*) The allowable working pressure of a corrugated pipe shall be computed as for the original pipe from which the corrugated pipe is made, based on the dimensions of the straight uncorrugated sections. If the corrugations are thinned down in the process of manufacture the thickness of such corrugations shall be used as the thickness of the pipe.

PAR. P-24 REVISED

P-24 Feedwater Piping. Feedwater piping (Par. P-317) shall conform to the requirements of Pars. P-9 and P-300. The minimum thickness shall be determined by the formulas in Par. P-23 or P-26 except that the value of P shall be not less than 1.25 times the lowest pressure at which any safety valve on the boiler drum, or water space, is set to blow. The S value used shall not exceed that permitted for the temperature of saturated steam corresponding to the set pressure of the safety valve, or the maximum water temperature to be handled, whichever is the greater. The value of P in the formula shall not be taken at less than 125 for any condition of service or material.

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[1] If pipe is ordered by its nominal weight or wall thickness, as is customary in trade practice, the manufacturing tolerance on wall thickness must be added to the t_m determined by the formula. The next heavier commercial wall thickness may then be selected from standard thickness schedules as given in ASA B36.10. The manufacturing tolerances are given in the several pipe specifications listed in Table P-6.

[2] When computing the allowable pressure for a pipe of a definite minimum wall thickness, the value obtained by the formulas may be rounded out to the next higher unit of 10.

[3] The factors of safety and allowance for joint efficiencies of welded pipe have been taken into account in the S values given in Table P-6. Where pipe is subjected to more than one "pressure-temperature" operating condition, the value of t_m shall be determined from the "pressure-temperature" operating condition which results in the maximum t_m except as provided in (*f*).

[4] The values of C stipulated above are such that the actual stress due to internal pressure in the wall of the pipe is less than the values of S given in Table P-6 as applicable in the formulas.

[5] The depth of thread h in in. may be determined from the formula $h = \frac{0.8}{n}$ where n is the number of threads per in. or from the following set of values:

n	h
8	0.100
11$^1/_2$	0.0696
14	0.0571

[6] Plain end pipe includes pipe joined by flared compression couplings, lap (Van Stone) joints and by welding, i.e., by any method which does not reduce the wall thickness of the pipe at the joint.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

A.S.M.E. Inland Empire Section Makes Fall Meeting at Spokane a Memorable Occasion

NEARLY three hundred members and guests attended the Fall Meeting of The American Society of Mechanical Engineers held at Spokane, Wash., Sept. 3-6, with headquarters at the Davenport Hotel. Technical sessions, catering to many interests, a great variety of side trips, excursions, and social events all combined to make this meeting a most enjoyable occasion.

At the Council Meeting on Tuesday morning there were present President Warren H. McBryde, past-presidents Harvey N. Davis and James H. Herron, vice-president W. Lyle Dudley, managers Linn Helander, Frank H. Prouty, Guy T. Shoemaker, and Willis R. Woolrich. Harte Cooke attended as chairman of the Standing Committee on Professional Divisions; R. L. Daugherty and H. J. McIntyre as guests; Ernest Hartford, assistant secretary, A.S.M.E.

Routine matters were handled and it was voted to express thanks and sincere appreciation to the Inland Empire Section for the very excellent program and arrangements for entertainment and for the plant visits provided by the various committees of the Inland Empire Section.

Technical Sessions

Technical sessions were on hydraulics, wood industries, materials handling, power, and process industries, with explanations of the Grand Coulee Dam project problems, recent developments in wood preservatives, utilization of waste lumber products, power-use future in the Pacific Northwest, electrometallurgical industries, and materials handling in the world's largest pine sawmill at Lewiston, Idaho.

H. V. Carpenter, dean of the college of mechanic arts and engineering, Washington State College, told the group that potentialities of the Pacific Northwest, when considered in relation to present developments, made the region still an industrial frontier. He pictured the attraction to industry and mining that the ultimate capacity of 2,373,000 kilowatts at Grand Coulee and Bonneville Dams will be.

William C. McIndoe, chemical engineer in the Bonneville marketing organization; A. E. Drucker, dean of the W.S.C. school of mines and geology; H. P. Nielsen, associate professor in the W.S.C. mines and metallurgy school, and R. O. Oscarson, Spokane, shared the power discussions in relation to the electrometallurgical industries.

Other sessions heard P. A. Kinzie and P. J. Bier, United States Bureau of Reclamation, Denver, tell how high-pressure conduit control gates and penstocks for Grand Coulee were designed to meet unusual demands and involved unusual designing and fabrication problems.

Transportation and handling of materials and equipment gave the dam builders other new problems, and Ray Fullerton, C.B.I. Construction Company, and Major S. E. Hutton of the Bureau of Reclamation told how these had been met.

A principal point of all speakers was that intelligent research work is preparing the Pacific Northwest for use of its natural resources when the power from the gigantic dams is fully available.

The detailed technical program of the Fall Meeting was published in the August issue of MECHANICAL ENGINEERING, page 629.

All-Day Trip to Grand Coulee Dam

Wednesday was given over to an all-day trip to the Grand Coulee Dam. Buses were chartered to take the group to the Dam where they were met at about 10:30 in the morning by engineer guides from the United States Bureau of Reclamation and conducted to the various points of interest. Special views from points of vantage, lectures, model demonstrations at the vista houses, and visits to the gravel pit and concrete aggregate preparation plant all made the morning trip well worth while.

Luncheon was served in the mess hall at the Consolidated Builders, Inc., at 12:30 p.m. and at 2:30 the group started out again for Dry Falls, driving through the upper section of the famous Grand Coulee, once the bed of a tremendous stream, a remnant of which is now the Columbia River. With a dam at each end the Grand Coulee forms a reservoir which will receive the discharge of the pumps located in a wing of the Coulee Dam. The water from this reservoir will then be distributed through canals to the 1,200,000 acres of land which will constitute the Columbia Basin Irrigation Project.

Dry Falls was reached in the early afternoon and was indeed worth the trip for the Falls, a geological wonder concerning which much has been written, were left behind by a stream whose flow was more than fifty times as great as the present Niagara River with more than twice its fall. This bed was left dry as mute evidence when the main stream through excavation resumed its still earlier outlet that had been temporarily dammed by the advance of glacial ice and its drift. It is now a State Park.

Program and News of the

1940 ANNUAL MEETING

will be found in the Special Insert Section, pages 847–854

Trips to Coeur d'Alene Mines and to Lewiston Mill

Another all-day trip was arranged on Friday to the Coeur d'Alene mining district with its mines one mile deep. The Hecla Mining Company's surface plant was inspected with its hoisting station and Star Mill. The Sunshine Mill surface plant was next inspected and then the Bunker Hill Smelter where the lead smelter and the lead and silver refineries were shown the visitors. The Sullivan Mining Company's electrolytic-zinc plant was the next to be inspected and the group was taken through the generator room, the cell rooms, and the zinc and cadmium casting plants.

Dinner was served on the return trip at the "Plantation" at Coeur d'Alene and the trip ended about nine o'clock in the evening at Spokane.

Another trip also on Friday which was particularly enjoyable was that to the Clearwater Mill and plant of the Potlatch Forests, Inc., at Lewiston, Idaho. Lewiston was reached just before noon where luncheon was served and then the trip to the mill actually began. The Clearwater unit is the largest white-pine mill in existence today and all usual operations in processing lumber are conducted on a very large scale. There are five band saws, a gang saw, and the usual edgers and end trimmers. The methods of handling and sorting at this plant are outstanding and embody many features not to be found in an average mill. The visitors were also interested in the manufac-

ture at this plant of the wood-briquette fuel made of clean, dry shavings.

Additional Trips

There were other inspection trips closer to the city that proved of interest to those attending the meeting, including several of the plants of the Washington Water Power Company, the Spokane Water System, and the plant of the Inland Empire Paper Company, whose output is now in excess of 30,000 tons of paper annually. A by-product of the plant is the sulphite solution which is used to lay dust on unpaved streets.

Social Events

The general luncheon held on Tuesday in the Hall of the Doges was the first of the social events of the meeting. Dean J. E. Buchanan, of the College of Engineering of the University of Idaho presided and introduced Frank G. Sutherlin, mayor of Spokane, who welcomed members of the Society and guests attending the Meeting. E. B. Parker, chairman of the A.S.M.E. Inland Empire Section, responded. The principal speaker at the luncheon was Charles Andrews, principal consulting engineer of the Washington Toll Bridge Authority who was substituting for Lacey V. Murrow, chief engineer of the Authority. Mr. Andrews delivered a very able address on The Lake Washington Pontoon Bridge.

Seated at the speakers' table for the luncheon were: Dean J. E. Buchanan; Charles Andrews; Frank G. Sutherlin; E. L. Haines, chairman, Spokane Section of A.S.C.E.; Bliss Moore, chairman, Columbia Section of A.I.M.E.; L. K. Armstrong, secretary, Columbia Section A.I.M.E.; H. B. Hodgins, chairman, Spokane Section A.I.E.E.; H. C. Bender, secretary, Associated Engineers of Spokane; Ernest Hartford, assistant secretary, A.S.M.E.; and E. B. Parker.

A.S.M.E. Calendar

of Coming Meetings

November 7–9, 1940
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Hotel Tutwiler
Birmingham, Ala.

December 2–6, 1940
Annual Meeting
Hotel Astor
New York, N. Y.

April 1–3, 1941
Spring Meeting
Atlanta, Ga.

June 16–20, 1941
Semi-Annual Meeting
Kansas City, Mo.

October 12–15, 1941
Fall Meeting
Louisville, Ky.

(*For coming meetings of other organizations see page 50 of the advertising section of this issue*)

Banks and Hutton Speak at Dinner Tuesday Night

At the general dinner on Tuesday evening, also held in the Hall of the Doges, Alfred D. Butler, city engineer of Spokane, presided. Speakers were Frank A. Banks, supervising engineer and Major S. E. Hutton, member A.S.M.E. and assistant director of information, U. S. Bureau of Reclamation, who took as their subjects the Grand Coulee Dam and the Columbia Basin Reclamation Project. Their talks were interesting and well illustrated. Coming right before the all-day trip to the Dam these talks were particularly well timed.

Grand Coulee Dam's power for commercial purposes will be completely marketed within 15 years after the completion of the project, Mr. Banks predicted.

"Notwithstanding that its fully developed power plant will be the largest in the world, its installation for commercial purposes (as differentiated from that for irrigation uses) will be fully loaded within 15 years, even if the rate of growth of the Pacific Northwest power market gradually declines to half the present in the next 30 years and Grand Coulee takes only half of the new business," he declared.

He said development of the Columbia Basin project will carry forward a program that began more than 100 years ago with the westward movement of hunters, miners, stockmen, farmers, merchants, and manufacturers.

Won't Balance Erosion

"Within five or six decades, it will add a million and a quarter acres of land—about one eightieth of one per cent—to the farmed and cropped area of the United States," he pointed out. "It will fall far short of balancing the concurrent loss of arable land by erosion, and it will not reclaim sufficient land to provide enough homes for either the natural growth of population or the Dust Bowl farmers banished by drought."

He said it will not aggravate the surplus-crop situation because surplus crops are not raised extensively, if at all, on irrigated land.

While it must always buy Eastern factory products and Middle West foodstuffs, the Far West must grow more foodstuffs and must develop industries peculiarly suited to it in the interest of the general economic good, he explained.

Student-Branch Breakfast

A student was elected at the breakfast on Thursday morning to act as presiding officer and F. B. Morse, who was graduated from Oregon State College in 1940, was chosen. Speakers were Prof. E. O. Eastwood, past vice-president, A.S.M.E., and head of the department of mechanical engineering at the University of Washington and President McBryde.

At the speakers' table were also Prof. R. T. Challender, Montana State College; Prof. Arthur D. Hughes, Oregon State College; Prof. R. W. Crain, University of Washington; Prof. F. H. Gauss, University of Idaho; Dean James G. McGivern, Gonzaga University; and Prof. F. W. Candee, State College of Washington.

Thursday's Luncheon

George F. Cornwall, managing editor, *The Timberman*, presided at the luncheon on Thursday at which the speaker was Sidney Jenkins, publicity director, Potlatch Forests, Inc., Lewiston, Idaho. Mr. Jenkins described the selective logging methods of Potlatch Forests in the Clearwater area which assures a new crop of merchantable trees every thirty years, and stressed the fact that there would be no more waste in lumbering. "I'm astounded at those who say there is no future in lumbering," Mr. Jenkins said. "The industry has been sick, but it is now convalescing. It will not die; it has a great future, if disease and fire can be kept from our forests." He concluded his remarks with a brief history of the Inland Empire, emphasizing its relation to the lumber business.

The Banquet

More than 300 delegates and guests attended the banquet in the Marie Antoinette Room of the Hotel Davenport on Thursday night, the final social event of the meeting.

The toastmaster was H. J. McIntyre, associate professor of mechanical engineering, University of Washington, with the president, Warren H. McBryde, San Francisco, and E. O. Eastwood, head of the department of mechanical engineering, University of Washington, speakers.

Ready to Serve

President McBryde said that in the national emergency the engineers will not be found wanting, nor in the demands upon them to rebuild a world from the present era of destruction.

Dr. Eastwood, at Washington since 1905, called for a return to the pioneer traditions of America, scoring what he termed the tendency of the "pioneers of today to rush to the marriage bureau, or the mechanical-engineering school," he added in jest, "to get out of the draft. I think today's generation owes some sort of obligatory service to the nation in payment of its debts to the pioneers."

The University of Washington engineering dean also expressed confidence that the 150,000 members of his profession will be ready to meet any call to service, and urged the coming members, represented by the student-engineer guests of the Old Guard, to prepare to do their part in the reconstruction of a war-torn world.

The Old Guard was represented by Harte Cooke, James G. Kingsbury, and James H. Herron.

Organ, Orchestra, Vocal Music

Organ music by Frances Tipton, assembly singing of "God Bless America," and an orchestra composed of Jane Berkey, cellist, Arthur Zepp, pianist, and James B. Clark, violinist, played during dinner. The after-dinner program was by Miss Frances Yeend, operatic soprano, Pullman, and the Spokane Elks' quartet.

Special Events for the Women

A special program was arranged for the women attending the meeting for in addition to the many events to which they were welcomed along with the men, a delightful motoring drive was arranged for Tuesday. Spokane's most beautiful residential areas and parks, Washington State Museum, Fort George

Wright, the famous Sunken Gardens of Manito Park, and Cliff Park were included.

A special tea was served at the Country Club on Thursday in their honor and golf guest tickets were supplied to those interested.

The Committees

Committee members responsible for the success of the Fall Meeting and to whom thanks should go for their many hours of service in this connection are

Inland Empire Section: Chairman, E. B. Parker, *vice-chairman*, Alex Lindsay, *secretary-treasurer*, Albert R. Karlsten. *Executive Committee*, H. F. Gauss, David R. Gray, and Howard H. Langdon.

Finance: Henry F. Gauss, *chairman*, Harry J. MacCamy, U. B. Hough, and Laurence W. Kemmish.

Hotel Committee: Albert R. Karlsten, *chairman*, Alex Lindsay, and Louis J. Pospisil.

Technical Sessions: H. H. Langdon, *chairman*, S. E. Hutton, H. V. Carpenter, and James G. McGivern.

Reception Committee: Alex Lindsay, *chairman*, H. V. Carpenter, James G. McGivern, and William Schroeder.

Entertainment Committee: David R. Gray, *chairman*, Alex Lindsay, Albert R. Karlsten, and Guy E. Thornton.

Plant-Inspections Committee: Louis J. Pospisil, *chairman*, Harry J. MacCamy, U. B. Hough, and Henry F. Gauss.

Signs and Printing Committee: Laurence W. Kemmish, *chairman*, William Schroeder, and Ammon S. Andes.

Registration Committee: Frank W. Candee, *chairman*, Laurence W. Kemmish.

Publicity Committee: James G. McGivern, *chairman*, Albert R. Karlsten, Stanley R. Hall, H. V. Carpenter, and Laurence W. Kemmish.

Women's Entertainment: David R. Gray, *chairman*, Mrs. David R. Gray, Mrs. Albert R. Karlsten, Mrs. Laurence W. Kemmish, Mrs. Alex Lindsay, Mrs. Harry J. MacCamy, Mrs. James G. McGivern, Mrs. Louis J. Pospisil, and Mrs. Frank W. Candee.

Joint A.S.M.E.-A.I.M.E. Coal Meeting to Have 12 Papers and Six Inspection Trips

Fourth Annual Meeting, Birmingham, Ala., Nov. 7–9

THE Fourth Annual Joint Meeting of the Fuels Division of the A.S.M.E. and the Coal Division of the A.I.M.E. will be held at the Tutwiler Hotel, Birmingham, Ala., Nov. 7–9, in cooperation with the Birmingham Section of the A.S.M.E. and the Southeast Section of the A.I.M.E. This meeting will feature 12 papers on the subject of the utilization of solid fuels in the steel industry.

Three Previous Meetings

The first joint fuels meeting of the two Societies was held in Pittsburgh, Oct. 27–29, 1937, with 300 members attending. A second joint meeting took place in Chicago, Oct. 13–15, 1938, with the Western Society of Engineers, the Illinois Mining Institute, and the Indiana Mining Institute participating. The third meeting was at Columbus, Ohio, Oct. 5–7, 1939, and held with the cooperation of the Columbus Section, A.S.M.E., and the Ohio Valley Section, A.I.M.E.

All technical sessions and social affairs of the fourth meeting will be held at the Tutwiler Hotel. Friday will be devoted to six inspection trips, as outlined in the program which follows. The Honorable Frank M. Dixon, Governor of Alabama, has consented to present the address at the banquet planned for Friday evening. Entertainment for the women will be ably taken care of by the Womans' Auxiliary of the Southeast Section, A.I.M.E., Mrs. James MacKenzie, president.

Alabama and Tulane Game

A gridiron battle between the University of Alabama and Tulane University will take place on Saturday afternoon, Nov. 9. Individual reservations must be obtained in advance from Prof. Russell Poor, Birmingham-Southern College, Birmingham, Ala. Because the football game will bring many visitors for the week-end, members are also urged to make their hotel reservations early.

A.S.M.E. members registered in the Fuels Division were mailed the final program, in the middle of October. Others may request programs directly from A.S.M.E. headquarters, 29 West 39th Street, New York, N. Y. The detailed program follows.

Program

THURSDAY, NOVEMBER 7

9:00 a.m. Registration

The registration fee of $4 includes luncheons, smoker, and banquet, but not golf and football

10:00 a.m. Opening Session

Cochairmen: C. E. Lawall, chairman of A.I.M.E. Coal Division, and John M. Gallalee, vice-chairman of the Birmingham Section, A.S.M.E.

Address of Welcome, by Commissioner W. Cooper Green, Birmingham, Ala.

Uses of Coal, by A. W. Gauger, mining experiment station, The Pennsylvania State College

Utilization of Coals or Coking Coals, by J. E. Tobey, vice-president, Appalachian Coals, Inc.

Progress Report on Coal Testing Code, by A.I.M.E.-A.S.M.E. Joint Committee

1:00 p.m. Luncheon

Speaker: Herbert C. Stockham, president, Stockham Pipe and Fittings Co., and president, Associated Industries of Alabama

2:30 p.m. A.S.M.E. Session

Cochairmen: R. A. Polglaze and S. D. Moxley

Influence of Flame Turbulence in Combustion, by B. J. Cross, Combustion Engineering Co., Inc.

Steam Generation in Steel Mills, by H. J. Kerr, Babcock & Wilcox Co. Paper will be illustrated with motion pictures by F. G. Ely, Babcock & Wilcox Co.

Sampling Characteristics of Coal, by P. Nicholls and B. A. Landry, U. S. Bureau of Mines, Pittsburgh Experiment Station

2:30 p.m. A.I.M.E. Session

Cochairmen: H. S. Salmon and D. H. Davis

A Laboratory Continuous Coal Pulverizer to Measure Net Power, by W. H. Coghill, U. S. Bureau of Mines, Southern Experiment Station

Symposium on Coal Drying

The McNally-Vissac Coal Drier, by M. W. Mellor and C. H. J. Patterson, McNally-Pittsburgh Manufacturing Corporation

Mill Drying of Coal, by M. E. Fitze, senior test engineer of power plant, Wisconsin Electric Power Co.

Heat Drying of Bituminous Coal, by W. S. McAleer, Koppers Rheolaveur Corp.

8:30 p.m.

Stag Smoker

FRIDAY, NOVEMBER 8

9:00 a.m. Inspection Trips

Trip No. 1, Alpha Portland Cement Co. and Woodward Iron Co.

Trip No. 2, Sloss-Sheffield Steel & Iron Co. and Woodward Iron Co.

Trip No. 3, Stockham Pipe & Fittings Co. and Woodward Iron Co.

Trip No. 4, Stockham Pipe & Fittings Co. and American Cast Iron Pipe Co.

11:30 a.m. Inspection and Lunch

Thomas plant, Republic Steel Corporation

1:30 p.m. Inspection Trip

Tennessee Coal, Iron, and Railroad Co.

7:00 p.m. Banquet

Toastmaster: John M. Gallalee

Address by the Honorable Frank M. Dixon, Governor of Alabama

SATURDAY, NOVEMBER 9

10:00 a.m. Closing Session

Cochairmen: J. D. Cudworth and A. W. Thorson

Design Features of the 900-Lb Plant of the Alabama Power Company at Mobile, by E. C. Gaston, Commonwealth and Southern Co.

Some Nonfuel Uses of Coal, by O. C. Ralston and the late M. W. von Bernewitz, U. S. Bureau of Mines, College Park, Md.

Excess Ash in Coke, by James P. Dovel, president, James P. Dovel & Co.

2:00 p.m. Football Game

University of Alabama Vs. Tulane University

2:00 p.m. Golf

Birmingham Country Club or Mountain Brook Country Club

Actions of A.S.M.E. Executive Committee

THE Executive Committee of the Council of The American Society of Mechanical Engineers met at the Hotel Mayflower, Washington, D. C., on Sept. 15, 1940. There were present: Kenneth H. Condit, Clarke Freeman, and W. H. Winterrowd, of the Committee; Harte Cooke (Professional Divisions); and C. E. Davies, Secretary. The following actions of general interest were taken.

Kenneth H. Condit's reappointment as A.S.M.E. representative on the Board of the United Engineering Trustees, Inc., for a term of four years, was confirmed.

A.E.C. Under Discussion

A. A. Potter, past-president A.S.M.E. and past-president American Engineering Council, was appointed to represent the A.S.M.E. at the meeting of the Board of Direction of the American Society of Civil Engineers, Cincinnati, Ohio, October 14 and 15, when the subject of support of the A.E.C. was to be discussed. The report of the Joint Committee to consider A.E.C. (see MECHANICAL ENGINEERING, October, 1940, pp. 769–770) was reviewed and discussed.

Committee on Consulting Practice

Authorization was voted of the appointment of a special committee of the Council on Consulting Practice "to deal with the present requests of the various federal agencies for the establishment of fees and other arrangements for consulting and other engineering services, and to represent the Society on any committee set up by the American Engineering Council to deal with this problem." The personnel of the committee is as follows: S. Logan Kerr, chairman, M. X. Wilberding, and Paul L. Batty.

Approval of Finance Committee Recommendations

Confirmation was voted of letter-ballot approvals of recommendations of the Finance Committee relating to the 1939-1940 budget, as follows:

To appropriate $500 for a special meeting of the Machine Shop Practice Division from the current year's budget, the meeting to be devoted to the forging and machining of shell, an urgent problem in national defense.

To make an additional appropriation for Local Sections in the amount of $465 from the current year's budget.

To allot $1500 for Petroleum Division support from the current year's budget.

To grant additional appropriation of $500 from the current budget to the Committee on Local Sections for membership development.

To amend the budget for the current year to provide $1350 for the preparation of complete information regarding the members and suitable classification thereof.

Confirmation of letter-ballot approvals of other Finance Committee recommendation of general interest was voted as follows:

The date of termination of the Tulsa Office to be as of Sept. 30, 1940.

To extend to Sept. 30, 1941, the policy of accepting at normal rate of exchange dues from members in those countries where the Society regularly expends funds, including members in Canada.

To extend to Sept. 30, 1941, the policy of suspended membership (of members in the war zone) upon request, without loss of membership seniority but with suspension of publications.

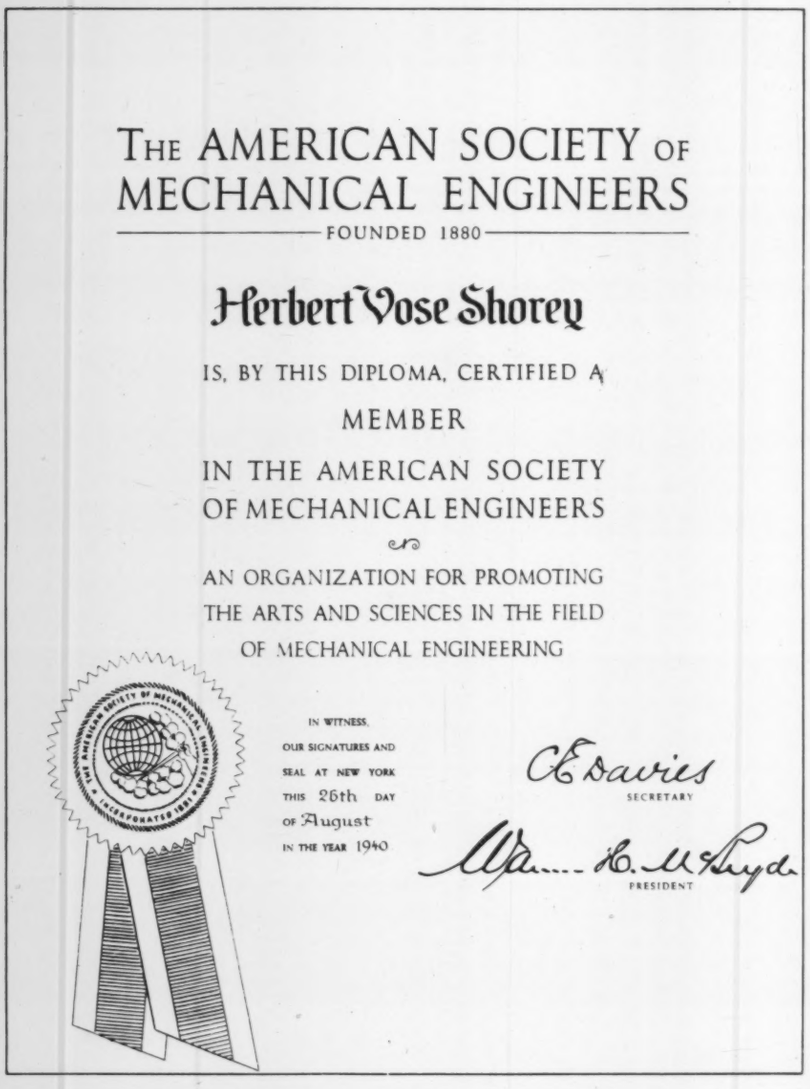
In view of the fact that members are being called into government service it was voted that such members may, on request, be excused, during such service, from payment of dues for the year ending Sept. 30, 1941, without affecting the continuity of service and with suspension of receipt of publications.

The following members were elected Fellows: William Le Roy Emmet, Sanford A. Moss, and Elmer H. Neff.

National Defense

As a result of a successful meeting held in Pittsburgh, Pa., Sept. 11, 1940, on the subject of shell manufacture (see MECHANICAL ENGINEERING, October, 1940, pp. 762–764) approval was voted of the formation of an Ammunition Group "to act as a clearing house on problems relating to the manufacture of ammunition, to carry on activities in ammunition that will be of aid to the defense program, and to be organized by the Special Committee on National Defense and the Machine Shop Practice and Metals Engineering Divisions."

Because Civil Service agencies have asked for a definition of the work of the mechanical engineer it was voted to ask the representatives



THE MEMBERSHIP CERTIFICATE—AVAILABLE FOR FRAMING

(Copies of The Membership Certificate, 8½ × 11 in., are available for framing. These may be ordered from A.S.M.E. headquarters at $1.50 each. They bear the engrossed name of the member, the grade of membership, date of election, and the signatures of the president and secretary. The gold seal of the Society and blue and gold ribbon are affixed as sketched. A period of a month may elapse between the date of order and the delivery of the certificate, because of the time required for engrossing the name and securing the necessary signatures. Its companion piece, the Code of Ethics, was published on page 766 of the October issue.)

of the Society on the Conference on Engineering Positions to prepare a definition of "Mechanical Engineer" and related definitions and to report them to the Council.

L. P. Breckenridge

The secretary was asked to send a letter of regret and tribute to the family of L. P. Breckenridge, past vice-president, who died on August 22, 1940. (See MECHANICAL ENGINEERING, October, 1940, pp. 738–739.)

New Certificate to Be Awarded

The proposal of the Railroad Division that a certificate be awarded to the Junior Member of the Society writing the best paper on a selected subject was approved, subject to the review of the Board of Honors and Awards and with the understanding that the traveling expenses of the winning contestant would not be borne by the Society treasury. It was suggested that the plan be tried first at the Kansas City Meeting in 1941.

Appointments

The following appointments were reported:

Tellers of Election: R. M. Baker, L. J. Beck, and O. B. Schier, 2nd

Power Test Codes Committee No. 17, Internal-Combustion Engines: Glenn C. Boyer, and Russell Pyles; Committee No. 13 on Refrigerating Systems: R. J. Ewer

Safety Sectional Committee on Safety in Quarry Operations: Redfield Proctor. Alternate: H. A. Collin

Boiler Code Subcommittees on Nonferrous Materials: W. F. Burchfield; on Heating Boilers: L. N. Hunter

Research Procedure Committee of Engineering Foundation: W. H. Fulweiler (reappointed, one year)

American Standards Association, Standards Council, Alternate representative: J. R. Weaver

Conference on Science, Philosophy, and Religion, Sept. 9–11, 1940, New York, N. Y.: Geo. A. Orrok

National Conference on Engineering Positions: W. F. Carhart, Walker L. Cisler, H. B. Oatley, and R. L. Sackett

Committee Asks Comments on Leather-Belt Standard

THE urgency of the times is resulting in thousands of manufacturing plants throughout the country reconditioning old machinery and installing new equipment. Since much of this machinery is driven by means of leather belting, it is appropriate to note that the draft of a proposed "American Standard for Specifications and Horsepower Ratings of Vegetable-Tanned Flat Leather Belting" has recently been completed by a sectional committee. This committee was organized under the procedure of the American Standards Association with The American Society of Mechanical Engineers as sponsor and the engineering committee of the American Leather Belting Association collaborating.

Drafts of the proposed standard are now being distributed to all industries concerned with leather belting for criticism and comment. Any engineer or company interested in this vital problem who has not received a copy may obtain one by writing immediately to George B. Haven, chairman, A.S.M.E. Sectional Committee on Standardization of Leather Belting, 29 W. 39th Street, New York, N. Y.

Cushing

NIGHT VIEW OF NEW YORK CITY FROM R.C.A. BUILDING

(A.S.M.E. Annual Meeting, New York, Dec. 2–6, see pages 847–854 of this issue.)

1941 Officers of A.S.M.E. Elected by Letter Ballot

WHEN the letter ballots received from A.S.M.E. members were counted on Tuesday, September 24, by the tellers of the election, Robert M. Baker, Lawrence A. Beck, and O. B. Schier, 2nd, a new record for the number of ballots cast was set. The total was 4012, but of these the tellers threw out 268 as defective. As usual, more than $3000 worth of checks and money orders were found in the ballot envelopes enclosed by members for their 1940-1941 membership dues despite requests that it be not done.

The final results, as tabulated:

Candidates	*Votes for*	*Votes against*
President:		
WILLIAM H. HANLEY	3571	173
Vice-Presidents:		
SAMUEL B. EARLE	3723	21
FRANK H. PROUTY	3733	11
EDWIN B. RICKETTS	3735	9
Managers:		
HUBER O. CROFT	3734	10
PAUL B. EATON	3731	13
GEORGE E. HULSE	3736	8

Herbert Hoover, honorary member A.S.M.E., received 155 votes of the 3744 cast for president in spite of his inability and ineligibility to run for the office as explained in his declination published in the September, 1940, issue of MECHANICAL ENGINEERING.

The new officers will be introduced and installed in office during the Sixty-First Annual Meeting of the Society to be held in New York, December 2–6, 1940.

Fifth Edition of "Who's Who in Engineering"

ENGINEERS throughout the country will soon receive material, questionnaires, and previously printed records bearing on the new (5th) edition of "Who's Who in Engineering." This work is being revised under the editorship of Dr. W. S. Downs, with qualifications established by a committee of the engineering profession, composed as follows: Andrey A. Potter, chairman, dean, Schools of Engineering, Purdue University; Col. L. B. Lent, vice-chairman, executive secretary, American Engineering Council; Frederic L. Bishop, secretary, Society for Promotion of Engineering Education; C. E. Davies, secretary, The American Society of Mechanical Engineers; H. H. Henline, secretary, American Institute of Electrical Engineers; T. Keith Legaré, secretary, National Council State Boards of Engineering Examiners; A. B. Parsons, secretary, American Institute of Mining and Metallurgical Engineers; George T. Seabury, secretary, American Society of Civil Engineers; Stephen L. Tyler, secretary, American Institute of Chemical Engineers; John A. C. Warner, secretary and general manager, Society of Automotive Engineers.

Glen L. Martin Awarded 1940 Guggenheim Medal

THE Daniel Guggenheim Medal Board announces the award for 1940 of the Daniel Guggenheim Medal to Glen L. Martin for contributions to aeronautical development and the production of many types of aircraft of high performance. Mr. Martin is president and chairman of the board of the Glen L. Martin Co. Plans for its presentation are in progress and will be announced later.

Engineering Societies Libraries to Dispose of 25,000 Duplicate Items

Director Craver Reports for 1939-1940

DISPOSAL of about 25,000 duplicate books and pamphlets held by the Engineering Societies Library, declared Dr. Harrison W. Craver, Director, in his annual report to the Library Board, presents a problem for which no satisfactory solution is apparent, and storage is fast becoming a burden upon limited space.

Members of the Board, over which A. R. Mumford, representative of The American Society of Mechanical Engineers, has presided as chairman for two years, discussed ways in which these duplicates could be disposed of to advantage, and authorized the Director to sell as many as possible to individuals and to give others to institutions, particularly libraries used or supported by the local sections of the engineering societies.

Pointing out that the expense of broadcasting the complete list of the 25,000 duplicates would exceed the revenue from possible sale of the item sought by book dealers, Dr. Craver expressed the hope that representatives of engineering libraries coming to New York to attend annual meetings of the engineering societies would look over the duplicate collection and select the items that would be of use to them. These, said Dr. Craver, would be gladly donated by the Engineering Societies Library provided arrangements were made to cover the cost of shipment.

J. L. Laist Elected Chairman

J. L. Laist, one of the representatives of the American Institute of Mining and Metallurgical Engineers, was elected to succeed Mr. Mumford as chairman of the Library Board.

Library Extensively Used

Dr. Craver reported that the library was used by 40,576 persons during the year. Of these 30,181 visited it and 10,395 were assisted by correspondence. This involved making 64 extensive bibliographies, 119 translations, 21,679 photoprints, and 14 microfilms for 2478 individuals. Two hundred and sixty-five books were lent to 221 members, 2572 letters were written in answer to inquiries, and 4927 telephone requests were attended to.

During the year 2822 books and 2765 pamphlets were added to the collection which now contains 149,734 volumes, 7636 maps, and 4473 manuscript bibliographic searches, a total of 161,843 items.

The library's lending policy, said Dr. Craver, was greatly liberalized during the year and as a result practically the whole collection is now available to any Founder Society member in the country, regardless of where he resides. Arrangements were also made during the year for interchange of facilities with the newly founded Paul Kollsman Library of the Institute of the Aeronautical Sciences, in New York.

A.S.M.E. Publishes the Emmet Autobiography

FOR more than a quarter of a century The American Society of Mechanical Engineers has been sponsoring the publication of biographies of eminent engineers in order to preserve for this and future generations an accurate account of their lives and activities.

Ten biographies bearing the imprint of the Society have already been published. Brief descriptions of these will be found on page 52 of the advertising section. The eleventh—the Autobiography of William LeRoy Emmet—has just been added to the series. It is reviewed at some length, page 829 of this issue.

H. T. Heald New President of Illinois Institute of Technology

HENRY T. HEALD, for two years president of Armour Institute of Technology, before its merger with Lewis Institute this year has been elected president of the new institution, the Illinois Institute of Technology.

James D. Cunningham, Fellow A.S.M.E., was elected chairman, and Alex D. Bailey, Fellow A.S.M.E., vice-chairman of the board of trustees of the Institute.

The merger of Armour Institute of Technology and Lewis Institute signals the completion of two years of effort of the respective Boards. The union results in the formation of a center of technological education having about 7000 students in the day and evening classes.

THE HENRY HUDSON PARKWAY IN NEW YORK

(See Special Section A.S.M.E. Annual Meeting, pages 847–854.)

D. B. Prentice President S.P.E.E.; Lamme Medal to A. A. Potter

AT the 48th annual meeting of the Society for the Promotion of Engineering Education, held in Berkeley, Calif., June 24–28, 1940, its Lamme Medal for Achievement in Engineering Education was awarded to A. A. Potter, past-president A.S.M.E., and dean of engineering at Purdue University. The citation said that the medal was given to Dean Potter "for his leadership in the advancement of the profession of engineering; for his devotion to high standards of teaching and his contributions to the development of engineering education; for his understanding of human nature and sympathetic interest in the work of his associates and students; for his sound judgment and his skill as an angineer; and for his untiring efforts in developing cooperative relations between engineering colleges and industry."

Officers of the S.P.E.E. for 1940-1941 elected at the meeting were: *President*, Donald B. Prentice, member A.S.M.E., and president of Rose Polytechnic Institute; *vice-presidents*, L. E. Conrad and E. L. Moreland, member A.S.M.E.; *secretary*, F. L. Bishop (re-elected); *treasurer*, F. L. Bishop, member A.S.M.E. (re-elected); and *assistant secretary*, Nell McKenry.

Norwegian Meteorologist to Give 1940 Wright Brothers Lecture

THE Wright Brothers Lecture for 1940 will be delivered in New York City on Dec. 17, by Sverre Petterssen, the Norwegian meteorologist, who this year was appointed professor of meteorology at the Massachusetts Institute of Technology, according to an announcement by the Institute of Aeronautical Sciences. As in past years, the selection of the lecturer is made by a committee composed of Americans who have delivered the Wilbur Wright Memorial Lecture before the Royal Aeronautical Society in London.

A.M.A. Production Conference, Cleveland, Nov. 12–13

THE fall conference of the American Management Association Production Division, to be held at the Hotel Cleveland, Cleveland, Ohio, Nov. 12–13, will cover the who, what, when, and how of the problem of production in the national defense program. Some of the items to be covered include selection and assignment of new men, training for immediate production, quality control, multiple-shift operation, cooperation with the government on defense production, and sabotage.

Woman's Auxiliary to A.S.M.E. Meets

MRS. George W. Farny, President of the Woman's Auxiliary, entertained the Auxiliary with a luncheon on Oct. 3 at her home, Craftsman Farms. Mrs. J. Ansel Brooks, chairman of the Calvin W. Rice Memorial Scholarship announced that Eduardo Ramon B. Abril of Cordoba, Argentina, is the first recipient of the award and that he will study at Massachusetts Institute of Technology, Dr. Rice's alma mater. It is her hope that this scholarship be made an annual one and that it be awarded to students from the different South American countries. Mrs. Roy V. Wright told of a pleasant meeting with the family of one of the earliest recipients of the Student Loan Fund. Mrs. A. H. Morgan, who is treasurer of the fund, reported the balance as encouraging.

It was particularly enjoyable to have twelve members from the Philadelphia Section present; the chairman, Mrs. J. Page Harbeson, Jr., spoke of their experiences in handling student loans.

Before adjourning to enjoy the autumn beauty of the garden, Mrs. E. C. M. Stahl, chairman of the Metropolitan Section of the Woman's Auxiliary, announced the first fall meeting of the Section for October 10 at the Engineering Societies Building. At this meeting plans for the Annual Meeting were discussed and later the guest speaker, Mrs. William C. Hammer, Director of Consumer Relations of the Celanese Corporation of America, gave a most interesting talk about her experiences.

Society Naval Architects and Marine Engineers to Meet Nov. 13–16

THE forty-eighth general meeting of The Society of Naval Architects and Marine Engineers will be held at the Waldorf-Astoria Hotel, New York City, Nov. 13–16. At the technical sessions on Thursday and Friday, Nov. 14 and 15, the following papers that are of interest to A.S.M.E. members are scheduled to be presented:

The David W. Taylor Model Basin, Part 2, by Capt. H. E. Saunders, U.S.N.

Some Policies of the United States Maritime Commission, by Rear Admiral Emory S. Land (CC) U.S.N. retired

Condenser Scoop Design, by E. F. Hewins and John R. Reilly

Feed Systems for Naval Vessels, by George B. Emerson

A New Type of Power-Torque Meter, by Dr. Wayne C. Hall

Engineering Features of the Maritime Commission's Program, by J. E. Schmeltzer

A Mercury-Propelled Cargo Ship, by W. Le R. Emmet

The program for the meeting and other information may be obtained from The Society of Naval Architects and Marine Engineers, 29 West 39th Street, New York, N. Y.

A SCENE AT THE SEPTEMBER 12 MEETING OF THE A.S.M.E. LOS ANGELES SECTION SHOWING PRESIDENT WARREN H. MCBRYDE PRESENTING 50-YEAR MEMBERSHIP PINS TO ERNEST W. WRIGHT AND GEORGE W. BISSEL WHILE P. L. ARMSTRONG, CHAIRMAN OF THE LOS ANGELES SECTION, LOOKS ON

Prizes for Papers on Railroads and Aviation Presented Before Local Sections by Juniors

Railroad Division and St. Louis Section Are Donors of New Prizes for Papers to Be Submitted Before Nov. 15

TWO new prizes for junior members of The American Society of Mechanical Engineers are being offered for papers presented before any one of the 70 Local Sections of the Society on the subjects of railroads and aviation. The Railroad Division of the A.S.M.E. will award a certificate and pay the traveling expenses to New York for the 1940 Annual Meeting for the best paper of not over 2500 words written by a junior (paying $10 annual dues) on the subject, "What Can the Young Mechanical Engineer Do for the Railroads?" It is not necessary to present the paper before a Local Section.

The St. Louis Section established in 1938 a fund administered by the Society which provides a cash prize of $50 to be awarded every three years, coincident with the awarding of the Spirit of St. Louis Medal, for the best paper written and presented since 1938 before a Local Section on some subject within the field of aviation. This prize, known as the Spirit of St. Louis Junior Award, is scheduled for presentation in 1941.

Papers for both contests must be submitted on or before Nov. 15, 1940, to the A.S.M.E. Board of Honors and Awards, 29 West 39th Street, New York, N. Y.

Warner & Swasey Plant Visited by Akron-Canton Section

FOLLOWING a dinner on Oct. 4 in Cleveland, 209 members and guests of Akron-Canton Section made an inspection trip through the plant of the Warner & Swasey Co., observing in particular turret lathes reproducing themselves, along with a multitude of other machining operations. The clean well-lighted shop was most favorably commented on by the visitors. James Forrest, member of the executive committee of the Section, presided at the dinner.

First Meeting of Baltimore Section Draws 140 Engineers

The Baltimore Section held its first meeting of the new season on Sept. 23 at the Engineers Club. About 140 members and friends heard R. E. Chestnut describe the new passenger-cargo, steam-driven ships being built at the Sparrows Point Plant of the Bethlehem Steel Co. for the Mississippi Shipping Company to be used in the South American trade. In his paper, illustrated by means of slides, Mr. Chestnut discussed mechanical equipment, the power plant, and auxiliary machinery. At the dinner preceding the meeting, G. H. Pouder, manager of the Export-Import Bureau of the Baltimore Association of Commerce, talked about the port of Baltimore and the effect of the war upon it.

Engineering Registration Subject at Birmingham

The subject at the Sept. 27 meeting of the Birmingham Section was the Alabama law re-

quiring the registration of engineers and surveyors. Col. A. C. Polk led the discussion in which he was joined by R. L. Polglaze, secretary of the Birmingham Committee, and Dr. J. M. Gallalee, vice-chairman of the Section. This meeting was in the nature of a smoker and social get-together.

Central Pennsylvania Hears Talk by H. P. Hammond

"Evolution of Engineering Education" was the title of the paper presented before 63 members and guests of the Central Pennsylvania Section by Dean H. P. Hammond at a meeting held on Oct. 4 at The Pennsylvania State College.

Chicago Section Opens Season With Smoker

Chairman L. M. Ellison of the Chicago Section opened the annual smoker on Sept. 27 with the traditional "Tappa-Nu-Keg" ceremony. This was followed by dinner, entertainment that was a veritable blitzkrieg of hilarity, bowling, bridge, billiards, and more liquid refreshments. The evening was greatly enjoyed by the 140 who attended.

Delray Power Plant Described to Detroit Members and Guests

About 150 members and guests of the Detroit Section heard P. W. Thompson, chief engineer of power plants, The Detroit Edison Co., speak on "Operating Economics at Delray," at the Oct. 1 meeting. Among the items of interest brought out by the speaker were the advantages of high-temperature steam coupled with modern turbine and generator developments for more efficient power generation. The technical session was preceded by an inspection tour through the high-pressure and low-pressure sections of the Delray plant.

Uniflow Steam Engines Discussed at Erie Meeting

The Erie Section held its first meeting of the season on Sept. 24 at the plant of the Skinner Engine Company in Erie, Pa. Herman Mueller, chief engineer of the company, spoke on the history of the uniflow engine, the use of various valve arrangements, forced-feed lubrication, and barrel-bored cylinders. After a spirited discussion, the 100 members and guests saw uniflow engines in the process of construction. Particularly interesting to all were the two 3500-hp, 5-cyl, double-acting uniflow engines in process of construction for the *City of Midland*, the largest car ferry in the world which is to be put into service on Lake Michigan.

Ithaca Section Members Visit Agfa Camera Plant

The Sept. 27 meeting of the Ithaca Section was held in conjunction with the Southern Tier Technical Society and followed an inspection of the Agfa Ansco Co. plant in Binghamton, N. Y. "Service Engineering for a Film Plant," was the title of the paper presented by H. W. Sachs, chief engineer of the company.

W. H. McBryde Is Guest of Los Angeles Section

President Warren H. McBryde was the guest of the Los Angeles Section at its Sept. 12 meeting. He spoke briefly on the activities of the A.S.M.E. for the present year, stressing especially its work and cooperation in the national-defense program. Following the talk, President McBryde awarded Fifty-Year Pins to Ernest W. Wright and George W. Bissel. The speaker of the evening, R. McC. Beanfield, member A.S.M.E., discussed the calcining of petroleum coke, the possibilities of using this coke to establish metal industries in the Los Angeles area, the problems in the construction of a coke calcining plant at Wilmington, Calif., and the ship-loading system.

Mid-Continent Section Hears About Oil-Field Equipment

D. O. Barrett, chief engineer of the Tulsa plant of the Gulf Oil Corporation, gave a paper on "Practical Developments in Oil-Field Equipment" before the Mid-Continent Section on Oct. 7. Several exhibits of equipment developed for the disposal of salt water and prevention of corrosion were shown. Mr. Barrett also described the work of the American Petroleum Institute on gearboxes and gas engines.

Nebraska Section Meets Jointly With Other Groups

The Oct. 2 meeting of the Nebraska Section was a joint affair of the A.S.M.E., A.I.E.E., and Omaha Engineers Club with the Student Branches of the A.S.M.E. and A.I.E.E. at the University of Nebraska as guests. Speaker at the noon meeting in the Elks Club was T. F. Peterson, American Steel & Wire Co., who discussed the "Cable Industry This Year and Next."

San Francisco Opens Season With Materials Handling Session

The romance of cement production from the quarry to the mill 300 miles away was graphically described to a large group of engineers at the opening meeting, Sept. 26, of the fall session of the San Francisco Section of the A.S.M.E. Members and their friends, including officers of the Navy and Marine Corps, were guests of the Permanente Corporation. They were taken on an inspection trip through the largest cement-producing plant in the world, located at Permanente, Calif. Operations were at full speed and the group was shown how the material is moved from the base rock at the crest of the mountain to the mill by belt conveyers, how the rock is segregated and sized, and how one of the important by-products, "sugar rock," is separated, later to be sold for sugar bleaching.

Following the visit to the plant many remained for dinner at the Stanford Union when a talk on "Cement Mill Operation" was given by Harry P. Davis, general superintendent of the Permanente Corporation who explained how, through modern engineering, the large quantity of natural cement rock had at last been made possible. The production rate is 1,000,000 tons a year with an anticipated source of supply for some 30 to 40 years.

The second speaker of the evening was A. L. DuBroy, general manager and chief engineer, Goodyear Tire & Rubber Co., Los Angeles. He described the mechanical features of materials handling at both the Permanente Plant and the Shasta Dam.

Discussion on both papers was lively and well sustained, showing keen interest in the general topic of materials handling and how modern methods in this field have made possible such tremendous operations.

It was a source of real satisfaction to the officers of the San Francisco Section that there were so many students in the audience. Santa Clara, University of California, and Stanford were all well represented.

Research in Peace and War at Utah Meeting

The Utah Section of the A.S.M.E. met jointly with the local chapter of the A.I.E.E. on Sept. 20 to hear Lawrence Hawkins, chief of research of the General Electric Company, talk about "Research in Peace and War."

Talk on National Defense Before Virginia Section

Charles W. Kellogg, president of the Edison Electric Institute and consultant of the National Defense Advisory Commission, gave an informal discussion of the Commission's work on matters connected with the defense problems of the United States at a joint session of the Virginia Section and Central Virginia Engineers Club held in Richmond, Va., on Sept. 25. Approximately 150 members of the two organizations were in attendance at the dinner meeting.

Washington, D. C., Section Issues News Bulletin

M. A. Mason, secretary-treasurer of the Washington, D. C., Section, is editor of a "News Bulletin" now being issued by the Section. In the first issue, various items of interest to local members are included. Of interest to members in other Sections of the A.S.M.E. is the announcement of an educational lecture course in the field of applied mechanics to start in January. A committee, under the chairmanship of Prof. J. W. Huckert, is arranging for nationally prominent speakers to present the contemplated series of eight lectures. Another course dealing with the engineering phases of aeronautics is being contemplated.

American Engineering Council

Presents

The News From Washington and Elsewhere

Employment of Engineers in Defense Program

ENGINEERS who wish to offer their services to the federal government in the defense program have three main avenues of approach: (1) Direct employment; (2) engagement on a consulting basis; and (3) as an employee or consultant of a contractor having a government contract.

A brief outline follows of how employment in any of these three categories may be accomplished.

Direct Employment

With relatively few exceptions, employment in government departments, bureaus, independent agencies, and the like is under civil-service rules and regulations. Competitive examinations produce so-called eligible lists, from which names are certified to those government agencies making requests. Personnel is being added to several agencies directly concerned with the defense program, such as War, Navy, and the Defense Commission, but most appointments are being made from civil-service eligible lists already in existence. And many jobs are being handled by calling reserve officers of the Army and Navy to active duty. Thus the chance of obtaining direct employment is somewhat remote for those not having civil-service status or not being in the organized reserves.

Consulting Basis

The engagement of engineers on a consulting basis is handled by each government agency in accordance with rules and regulations of long standing, although in a few cases recent simplifications to expedite procedure have been made. In general, compensation is on a per diem basis and only in exceptional cases does the rate exceed $25 per day. Many government agencies at times use consultants, but at the present time and in carrying out the defense program, the Army, Navy, and the Panama Canal are the principal agencies now taking on engineering consultants.

Applications for consulting work in the Army are being handled by the recently appointed Construction Advisory Board consisting of Francis Blossom, Forrest S. Harvey, and J. F. C. Dresser. Communications to this board should be addressed to 1125 Munitions Building, Washington, D. C. Requests for consideration should be accompanied by a full statement of experience records, especially records of jobs accomplished. Applications from engineering firms as well as from individuals may be sent to th s board.

A similar list for the Navy is being compiled by Lieut. A. D. Hunter, Bureau of Yards and Docks, Navy Department, Washington, D. C.

As is generally known, the A.S.C.E., A.S.M.E., A.I.E.E., and some other engineering bodies have sent questionnaires to their members to compile information regarding those individuals or firms who are available for consulting work. The information gleaned from the questionnaires is now filed with the more important government agencies. Members of engineering societies should address their communications in connection with these questionnaires to the secretaries of their respective societies.

Contractors' Staffs

Contractors on defense work will of course engage their own employees and consultants. The policy adopted by the government is to award contracts, whether for the consulting services of engineers, or for construction, to those qualified to handle the work who reside in the region where it is to be done. In a few cases, the construction contract also includes the design, but this is exceptional. However, engineering firms who are also engaged in the contracting business might well make their qualifications known to the Construction Advisory Board.

It should be understood that the National Defense Advisory Commission itself awards no contracts, but merely serves as a coordinator to assist the regular federal agencies in carrying out their individual programs.

Committee to Advise on Defense Training

TO assist in the task of utilizing the facilities of engineering schools and colleges in the emergency training of workers for defense industries, John W. Studebaker, U. S. Commissioner of Education, has appointed a special advisory committee composed as follows: Chairman, Andrey A. Potter, past-president A.S.M.E., dean of engineering, Purdue University; R. E. Doherty, president, Carnegie Institute of Technology; Gibb Gilchrist, dean of engineering, Texas A.&M. College; H. P. Hammond, member A.S.M.E., dean of engineering, The Pennsylvania State College; W. O. Hotchkiss, president, Rensselaer Polytechnic Institute; R. S. McBride, consulting engineer; Thorndike Saville, Mem. A.S.M.E., dean of engineering, New York University; C. C. Williams, president, Lehigh University; B. M. Woods, member A.S.M.E., chairman, department of mechanical engineering, University of California; F. L. Bishop, secretary, Society for the Promotion of Engineering Education; Allen W. Horton, Jr., U. S. Office of Education (Secretary).

It will be the task of this committee to aid in devising ways and means of best utilizing the teaching staffs and plants of technical schools in presenting special courses, not necessarily for students of collegiate grade, designed to furnish special skills needed in carrying out the defense program. Funds for this purpose have already been appropriated.

A.S.M.E. Local Sections

Coming Meetings

Anthracite-Lehigh Valley. November 22. Americus Hotel, Allentown, Pa., at 8:00 p.m. Dinner about 6:30 p.m.; ten-minute historical summary of "Mack Manufacturing Corporation." Subject: "Preventive Maintenance in the Operation of Motor Vehicles," by Belden H. Eaton, motor-vehicle superintendent, Pittsburgh Division, Bell Telephone Company.

Baltimore. November 25. Dinner at 6:15 p.m. Address at 8:15 p.m. at the Engineers' Club of Baltimore. This is a joint interprofessional meeting with the Investment Bankers Association of America. Subject: "Financing of Engineering Projects," by Emmett F. Conley, president of the Investment Bankers Association of America.

Chicago. November 6. Theater on the 36th floor, Civic Opera Building, Chicago, Ill. Meeting to be sponsored by the Transportation Division of the Section.

November 12. Classroom on the 36th floor, Civic Opera Building, Chicago, Ill. Meeting to be sponsored by the Junior Group of the Section on the subject of "Heat Transfer."

November 20. Theater on the 36th floor, Civic Opera Building, Chicago, Ill. Meeting to be sponsored by the Research Division of the Section on the subject of "Scientific Tools."

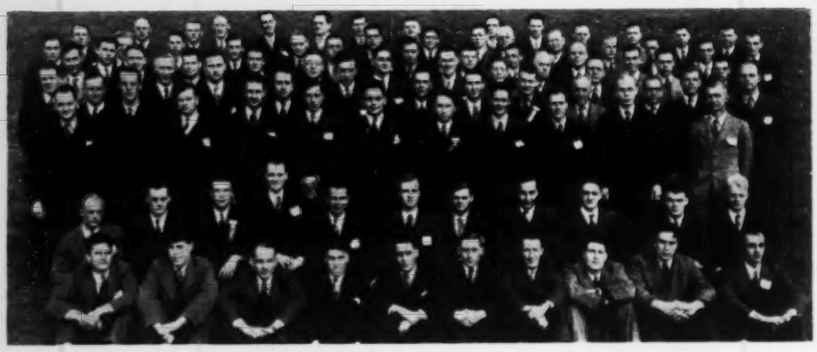
November 26. Meeting to be sponsored by the Manufacturing Division of the Section on the subject of "Industry and Rearmament." This will be a dinner meeting.

Detroit. November 5. L'Aiglon Fisher Building, Detroit, Mich. Subject: "Precision Boring and Thread Grinding," by Ira Snader, research engineer of the Ex-Cell-O Corporation. Inspection trip to the Oakman Boulevard Plant.

Norwich. November 13. New London, Conn., at 8:00 p.m. (exact place not yet determined). Subject: "High-Speed Photography," by Prof. W. H. Edgerton (tentative), The Massachusetts Institute of Technology, Cambridge, Mass.

Virginia. November 9. Patton Engineering Hall Auditorium, V.P.I., Blacksburg, Va., 10:00 to 12:00 a.m. Joint Meeting with the Student Branch at Virginia Polytechnic Institute. Subject: "Marine Terminal for City of Richmond," by G. C. Molleson, department of public works, City of Richmond, Va. Three student members of the V.P.I. student branch will also appear on the program, presenting papers of general interest in the mechanical-engineering field.

Washington, D. C. November 14. Potomac Electric Power Co. Auditorium at 8:00 p.m. Subject: "Ship Design and Construction," by Captain Lybrand Smith, Lieut.-Com. W. C. Latrobe, Lieut. P. W. Snyder, Bureau of Ships, U. S. Navy.



GROUP VIII—PACIFIC NORTHWEST STUDENT MEETING, MOSCOW, IDAHO—PULLMAN, WASH., APRIL 29–30, MAY 1

With the Student Branches

A.S.M.E. Student Branches Open 1940-1941 Year With Smokers and Technical Meetings

THE 118 Student Branches of The American Society of Mechanical Engineers opened the 1940-1941 year with "get-acquainted" smokers and technical meetings at which prominent engineers or the members themselves presented engineering papers. Some Branches have planned their program for the rest of the year while others only made arrangements for the next meeting.

Besides taking part in their own Branch meetings, student members have the privilege of attending the Local Section meetings held in their vicinity and the national meetings of the Society. Many students are already making plans to attend the 1940 Annual Meeting in New York City, Dec. 2–6, at which each Branch representative will be the guest of the Old Guard at the banquet on Wednesday evening, Dec. 4. The banquet will conclude the special program planned for that day which will be known as "A.S.M.E. Student Day." Following a student meeting in the morning, the boys will join distinguished members of the Society for the annual student luncheon. In the afternoon, each student member will be able to attend one of the regular technical sessions of the Annual Meeting or go on one of the interesting inspection trips.

But, of immediate interest to student members is the news of happenings in their own and other Branches throughout the United States and Canada. For that purpose, the secretaries send in reports of meetings, inspection trips, and social affairs so that the editor may compile a running account of such happenings for these pages. The following news items were taken from reports received at A.S.M.E. headquarters up to Oct. 6, 1940.

California Welcomes President

CALIFORNIA BRANCH began functioning on Sept. 19 with a meeting attended by 67 members and 13 guests. Chairman Don Graham opened the meeting by requesting Dan Drake to lead the group in singing, after which dinner was served. Following an excellent repast, vice-chairman Hugh Gourdin introduced the guest of honor, President Warren H. McBryde of the A.S.M.E., who gave an interesting talk on "What Is Engineering?" The meeting concluded with piano selections by Bill Price.

New Officers at C.C.N.Y.

New officers of the C.C.N.Y. BRANCH were installed on Sept. 26 together with a new honorary chairman, Prof. Stephen J. Tracy. With the aid of the 42 members who were present, the officers made plans for future meetings on the subjects of the engineer in the army, problems of power generation, and power-plant engineering.

Colorado State Has Luncheon

Following the first meeting of the COLORADO STATE BRANCH on Sept. 16, at which J. T. Strate of the faculty discussed the advantages of A.S.M.E. membership, the 29 boys who were present adjourned to the mechanical-engineering laboratory where luncheon was served.

Cornell and Employment

Of the 148 members of the 1940 graduating class in the college of engineering at CORNELL UNIVERSITY, 142, or 96 per cent, are known to have definite employment, according to a statement issued on Sept. 14. Placement is 100 per cent for chemical and electrical engineers, 97.6 for mechanical engineers, 95.4 for administrative engineers in mechanical engineering, and 89.3 for civil engineers.

Two Branches Merge at Illinois Institute of Technology

On Friday, Oct. 4, 1940, the first meeting of the I.I.T. Student Branch of the A.S.M.E. was held. Resolutions were read that had been passed at the meeting of Sept. 21 as follows:

WHEREAS: there has been a merger of the

NINTH ANNUAL MEETING, A.S.M.E. GROUP IV, SOUTHERN STUDENT MEETING, BIRMINGHAM, ALA., MARCH 31, APRIL 1–2

Armour Institute of Technology and Lewis Institute, with a corporate name of Illinois Institute of Technology and

WHEREAS: each of the merging Institutes has had an active Student Branch of the A.S.M.E. with regular complement of elected officers, and

WHEREAS: the rules of the A.S.M.E. call for only one Student Branch at any engineering college,

Therefore be it resolved: that the following action be taken by a group of mechanical engineering students at Illinois Institute of Technology to provide for the 1940-1941 year pending a regularly organized Branch thereafter.

(1) That a petition be made to the A.S.M.E. for a Student Branch at the Illinois Institute of Technology.

(2) That it is herewith recommended that all funds and other property of the A.S.M.E. Student Branches of the two merged Institutes be transferred to the new A.S.M.E. Branch to be formed at the Illinois Institute of Technology.

(3) That it is recommended that the duly elected officers of each Branch of the two merged Institutes request formal dissolution of these Branches from the A.S.M.E.

(4) That for the 1940-1941 school year, there be established the regular officers of chairman, vice-chairman, secretary, and treasurer, chosen by ballot, or rising vote, from the two sets of officers of the merged Institutes, on the basis of two officers from each Institute.

(5) That the newly proposed Student Branch of the Illinois Institute of Technology vote at a regular business session for its recommendations for Honorary Chairman not later than 60 days after the National Society's approval for the Branch.

(6) That subsequent officers be chosen by regular means provided by the rules of the parent organization.

(7) That a set of these resolutions and a copy of the minutes of the meeting be sent to the parent organization for special action and approval.

The following members were recommended by the nominating committee for the vacant offices: Chairman, John Savauge; vice-chairman, Raymond Geisler; secretary, Thaddeus Wieczorek; treasurer, Edward Floreen.

A motion was made and seconded, that the slate presented by the nominating committee be accepted.

1939-1940 BUCKNELL STUDENT BRANCH

Mississippi State Smoker

MISSISSIPPI STATE BRANCH opened its season with a smoker on Oct. 2 at which the new officers and the honorary chairman, Prof. H. P. Neal, were introduced. After a brief address of welcome by chairman J. B. Buescher, the 108 who were present saw motion pictures on automotive construction and the oil fields of Europe. Prof. A. G. Holmes, Jr., head of the mechanical-engineering department, stated that any student member presenting a paper at the A.S.M.E. Student Conference next spring would be given several credits toward graduation.

Nebraska Has Joint Meeting

The Sept. 25 meeting of the NEBRASKA BRANCH was held jointly with the student chapter of the A.I.E.E. in preparation for a joint inspection trip on Oct. 2. The first speaker, W. R. Hazleton, Nebraska Power Co., described the Jones Street Power Station in Omaha. The second guest speaker, Don Thomas, Loup River Public Power District, discussed the interconnection between the Nebraska hydroelectric system and the various power markets in Nebraska, particularly Omaha.

Northeastern Reports 3 Meetings

Earl Finkle, corresponding secretary of the NORTHEASTERN BRANCH (division A), sent in reports of meetings held on Sept. 12, 17, and 23. The first meeting was devoted to an election of new officers. The next meeting provided an opportunity to all members to discuss the type of program they desired at future meetings. So, on Sept. 23, the members made an inspection trip to the Cambridge Ice Company plant, the largest of its kind in the Boston area.

Notre Dame Gets 26 New Members

The meeting on Sept. 19 of the NOTRE DAME BRANCH saw the introduction of the new officers and the enrollment of 26 members. Refreshments were served during the meeting.

EIGHTH ANNUAL MEETING, A.S.M.E. GROUP II, EASTERN STUDENT MEETING, NEWARK, N. J., APRIL 29–30

Oklahoma Branch Makes Plans

At the Sept. 30 meeting of the OKLAHOMA A.&M. BRANCH, plans were made to attend the Oct. 7 meeting of the Mid-Continent Section in Tulsa, and for a meeting which would be a round-table discussion of some interesting engineering topic by a group of engineers from Tulsa and Oklahoma City.

Sports at Pittsburgh

A meeting of the PITTSBURGH SECTION was called to order on Oct. 3 by Chairman H. G. Skinner. Charles Shank announced that the M.E. teams for intramural sports needed a few more candidates. Following this, those elected to Pi Tau Sigma were introduced.

Purdue Hears About Oil

The first meeting of the PURDUE BRANCH for the season was held on the evening of Sept. 19. The main event was an address by Dr. E. M. Kemler on the subject, "Engineering in the Oil Industry," in which he showed the highly important part played by the engineer in this very "speculative" business. A door prize of a free student membership was awarded to the student who drew the lucky sample copy of MECHANICAL ENGINEERING, the distinguishing mark being a hole punched through one of the inner pages. The winner was Alvin W. Meyers.

R.P.I. Students in Industry

A new plan in engineering education was put into practice at RENSSELAER POLYTECHNIC INSTITUTE this fall. Through the cooperation of the General Electric Company, a large group of carefully selected students will "go to school" for three consecutive months in the company's plants. The plan differs from other cooperative arrangements in that the graduation of the students takes place within the regular four-year period. This is accomplished mainly by including a classroom program to run concurrently with the practical experience program. Another feature of the plan is that these courses will be concentrated on three consecutive months in the junior year alone. Students undertaking the training will receive from $75 to $125 over living expenses.

Pep Talk at Rhode Island State

The first meeting of RHODE ISLAND STATE BRANCH on Oct. 2 was opened with a pep talk by Chairman Robert Afflick in which he showed the advantages of A.S.M.E. membership. Then John Chrissos explained the functions of the Army Ordnance Reserve.

100 Per Cent Attendance at Rose

The first meeting of the ROSE POLYTECHNIC BRANCH on Sept. 25 was notable for the reason that there was 100 per cent attendance of all mechanical-engineering students eligible for membership. Prof. Carl Wischmeyer, honorary chairman, outlined the reasons for A.S.M.E. membership.

U.S.C. Branch Plans Activity

At the first meeting of the UNIVERSITY OF SOUTHERN CALIFORNIA BRANCH held on Oct. 1, 37 students made application for membership. The program consisted of talks by members of the mechanical-engineering faculty on A.S.M.E. membership, the research program carried on by the Society, and the history of the Branch.

Joint Course at Stevens and Newark

A cooperative arrangement between NEWARK COLLEGE OF ENGINEERING and STEVENS INSTITUTE OF TECHNOLOGY is in operation this year whereby certain of the advanced evening courses offered by NEWARK, amounting to not more than 10 credits, may be credited toward the requirements of the degree of master of science at STEVENS.

Texas Hears About C.A.A. Plan

A period of strictly supervised training and not merely a chance to joy-ride, was how R. L. Browning, head of the local division of the C.A.A., described the civil pilot-training courses now being offered to young men and women, at the Sept. 30 meeting of the TEXAS BRANCH. Among the advantages of the program enumerated by Mr. Browning was the fact that this preliminary training not only enables the student to take advanced training but also may afford an opportunity to enter the United States Army Air Corps as a military pilot.

Villanova Starts Ball Rolling

VILLANOVA BRANCH started the school year off with a meeting on Sept. 30 at which application blanks were distributed. Besides the regular technical meetings which are held periodically, the Branch is planning a smoker for Nov. 14.

Men and Positions Available

Send inquiries to New York Office of Engineering Societies Personnel Service, Inc.

29 W. 39th St. New York, N. Y. | 211 West Wacker Drive Chicago, Ill. | 57 Post Street San Francisco, Calif. | Hotel Statler Detroit, Mich.

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 26, M.I.T. 1935. In large machine-tool plant: 15 months shop apprentice, 2 years installing bonus-incentive system. Two years equipment engineer for automatic-machine manufacturer. Location, immaterial. Me-545.

LUBRICATION ENGINEER, B.S. in M.E., M.S., 28, married. Now employed as industrial lubricants salesman by major oil company. Familiar all phases blending, marketing, and distributing petroleum products. Seeks sales-engineering position, same or affiliated industry. Will travel. Me-546.

MANUFACTURING PLANT MANAGER OR CHIEF ENGINEER, 46, single, technical graduate. Broad general mechanical- and electrical-engineering experience. Successful plant executive (diversified woodworking), organizer, systematizer, coordinator. Now employed. Me-547.

MECHANICAL ENGINEER, 39 years old, married. Experiences: 3 years shipbuilding, 11 years materials-handling equipment; 7 years with food and chemical plant as assistant to plant engineer on new equipment and new expansion. Me-548.

INSTRUCTOR IN MECHANICAL ENGINEERING. Have taught engineering drawing, hydraulics, mechanical laboratory, thermodynamics, machine design and kinematics. Two years of industrial experience. B.S. and M.S. degrees. Me-549.

ENGINEER, 44, college, registered. Twenty-eight years engineering design, construction, and production; factory engineering and operation; chemical plant and equipment design; production control and inspection methods; active charge. Mature judgment. Me-550.

MECHANICAL ENGINEERING GRADUATE, 23, 1940 graduate of leading engineering school. Courses in power-plant design, refrigeration, steam-turbine design, internal-combustion engines, theory of combustion, etc. Ambitious, neat appearance. Me-551.

MANAGEMENT EXECUTIVE, 31, B.S. Three years graduate studies; nine years' diversified experience: Factory management, production, methods, costs, design, personnel, tabulating, office, marketing analysis. Employed production manager large nationally known corporation. Me-552.

MECHANICAL ENGINEER, graduate, 25, single. Experience in design, operation, and management of plant manufacturing powdered metal; also in purchasing. Now employed, prefers position in East, preferably in machine design. Me-553.

MECHANICAL ENGINEER, 1939 graduate, B.S., 23. Realizes college training only theoretical, therefore willing to get into overalls to learn actual facts. Likes responsibility. Interested in heat-power engineering. Me-554.

CHIEF ENGINEER, technical graduate with very worth-while experience in plant layouts and engineering, equipment design and development, construction and power, maintenance and drafting-force supervision, particularly in chemical and food industries. Me-555.

MECHANICAL ENGINEER, B.S. in M.E., and M.E., 45, married. Seven years experimental, design and research in important manufacturing plants; 15 years' broad teaching experience in colleges. Member rating and licensed. Me-556.

MECHANICAL-ENGINEERING GRADUATE, 24, single. Three years' experience in rate and production work. Also three summers' experience in railroad maintenance work. Desires position in maintenance department railroad or industrial production work. Me-557.

STEEL-PLANT CHIEF ENGINEER. Wide experience in design and construction of all types of steel-plant equipment, especially in flat rolled products. Good references. Me-558.

GRADUATE MECHANICAL ENGINEER. Service engineer with boiler manufacturer, designing

[1] All men listed hold some form of A.S.M.E. membership.

and servicing boilers and related equipment. Purdue 1935 and advanced courses. Available on notice for power-plant, combustion, and allied work. Me-559.

GRADUATE MECHANICAL ENGINEER, Cornell University, 1935, M.E. Anglo-Saxon, American citizen. Time study 1½ years. Design work, 2½ years on small production mechanisms. Desires designing position. Me-560.

POSITIONS AVAILABLE

DESIGNERS with well-rounded experience in mechanical instrument design. Applicants must have experience with small precision parts such as gears, cams, and lever motions. Salary, $3000–$3600 year. New York metropolitan area. Y-6456.

GRADUATE ENGINEERS, 22–30, preferably with textile experience who would be interested in position in production end of cordage company. Applicants will be trained in manufacturing end of business. Excellent opportunity for advancement. East. Y-6463.

SUPERINTENDENT OR ASSISTANT SUPERINTENDENT thoroughly experienced in machine shop and punch-press work, for company manufacturing electric motors from ¼ to 15 hp. Should have ability to reduce costs and increase production. Ohio. Y-6465D.

GRADUATE ENGINEER with wide and varied experience to organize department for maintenance of perpetual inventory. Must be acquainted with securing book values and applying costs in event that these cannot be secured. Work will involve wide variation of material such as furniture, laboratory equipment, and machinery, including power plant and waterworks, as well as individual motor drives. Must be good executive and capable of directing organization. One-year contract; probably renewal. Salary, about $4500 year. Pennsylvania. Y-6476.

DIESEL ENGINE DESIGNER with experience in fundamental design, who can make stress and load calculations. Degree not essential but, if possible, company wishes man with experience in Diesel-engine work, particularly valve and control mechanism design. Salary, up to $275 a month depending upon experience. Southern Wisconsin. Y-6485-R809C.

MACHINE DESIGNER, graduate mechanical engineer, with some experience on board, designing, if possible, and detailing light and heavy machinery. Applicant will be placed under supervision squad leader with thought of advancement to this position. Should have at least 5 years' experience. Must be American citizen. South. Y-6488.

PURCHASING AGENT, with chemical background, to purchase material for company manufacturing fireworks. Plant includes powder mill, paper mill, and box plant. Prefer man with thorough knowledge of New England market. Salary, $3600–$5000 a year. New York. Y-6491.

DESIGN AND DEVELOPMENT ENGINEER, 35–50, especially qualified to design mechanical instruments. Should have had at least 8 to 10 years' experience in this field. Must be American citizen. Salary open. Ohio. Y-6499.

EXECUTIVE, 35–45, graduate in mechanical engineering from recognized engineering school. Should be top-notch mechanical engineer and have demonstrated extraordinary ability as executive and engineer. Should, at present time, hold responsible engineering or administrative position, preferably in heavy-equipment industry, and earning not less than $10,000 annually. Location, East. Y-6504.

PLANT SUPERINTENDENT, preferably 35–40, for machine shop manufacturing special light machinery item; manufacturing is largely in the nature of job work. Applicant would be expected to take complete charge and have full responsibility in operation of manufacturing departments. Must understand machining of hard alloys and wide variety of alloys in form of castings and also in sheet and tube stock. Will be required to keep adequate records on manufacturing activities, handling of all personnel problems including wage setting, etc., planning and routing of orders, assistance in setting up and operation of any machine in plant; must have ability to design at least simple tools. Good appearance and personality. Salary, $55–$60 a week. Excellent opportunity. New York State. Y-6530.

ENGINEER, 30–35, interested in position in negotiation department of large company manufacturing electric machinery. No outside sales work involved but applicant should have previous sales contacts. Duties will include working up of estimates, preparatory to quoting, on inquiries particularly on export work. Knowledge of export situation desirable but not essential. New York, N. Y. Y-6533.

DESIGNER, 30–40, who has special qualifications and experience in design of equipment for high-pressure synthesis operations. Should have thorough knowledge of stress analysis, plasticity, and metallography of steel. It is desirable that applicant be experienced in design of heavy machinery, such as hyper compressors and converters and be acquainted with shop practice with some experience in direction of designers and draftsmen. Salary open. Location, East. Y-6536.

GRADUATE MECHANICAL OR METALLURGICAL ENGINEER, young, to learn wire-and-cable business and eventually work into sales department of organization. Should have some sales experience or at least desire to enter sales work. Some metallurgical experience desired. Salary, $25 week. Location, New England. Y-6544.

SUPERINTENDENT, not over 34, for power plant consisting of total installed turbine capacity of about 7500 kw; the boiler capacity consists of eight 300-hp Edgemoor boilers. Will also be required to supervise maintenance and changes in power equipment and distribution system to mills, employee housing, etc., and assist in overhauling and modernizing of plant. Must have had practical and theoretical experience and be, preferably, single. Location, foreign. Y-6560.

MAINTENANCE FOREMAN, preferably college graduate, who has had 3 to 10 years' experience in plant-maintenance supervision. New York State. Y-6562.

MATERIAL RECORDS ENGINEER experienced in engineering practice and terms, combined with some knowledge of purchasing material and scheduling and planning work. Must be American citizen. State salary expected. Transportation furnished. South. Y-6578.

DRAFTSMAN, 35–50, with considerable experience in drafting room, in power-plant work of all kinds, including piping layouts, foundations, structural design; some experience on electrical layouts desirable but not essential. Applicant must be tactful and have ability to command respect of others. Excellent opportunity for advancement. Salary, $350 a month. Ohio. Y-6581D.

GRADUATE MECHANICAL ENGINEER, over 25, with experience in scheduling and planning work and a leaning toward industrial-engineering field. Will be required to help set up and operate production department. Pennsylvania. Y-6582.

GRADUATE MECHANICAL ENGINEERS, young, with 2 to 5 years' experience in time study and industrial engineering in general. Salary, $150–$200 a month. New England. Y-6598.

Civil Service Positions

Applications may be secured from U. S. Civil Service Commission, Washington, D. C., or any First-Class Post Office

AIRCRAFT PROCUREMENT INSPECTOR, assistant to senior grades, $2000 to $2600 a year. Optional subjects include aircraft, engines, instruments, parachutes, aircraft propellers, and tools and gages. Positions are open at Wright Field, Dayton, Ohio. There is no written test. Applications will be accepted until further notice.

INSTRUCTOR, Air Corps Technical School, junior to full grades, $2000 to $3800 a year. Requirements include graduation from high school and completion of 4 years of experience as instructor in shop subjects or as a shop supervisor, although engineering experience may be accepted. Maximum age is 53 years. Applications will be accepted until further notice.

ENGINEER, assistant to senior grades, $2600 to $4600 a year. Requirements include completion of a four-year course leading to a bachelor degree in engineering in a college or university of recognized standing. Maximum age is 55 years. Closing date is June 30, 1941.

INSPECTOR, junior to senior grades, $1620 to $2600 a year. There are three tests under this title, one for engineering materials (aeronautical); the second for ship construction (hulls, mechanical, electrical); and the third for engineering materials (hulls, mechanical, electrical, and radio). Applicants must have had inspectional experience. Maximum age for junior grade is 35 years, and for other grades is 55 years. Applications will be accepted until further notice.

Civil Service positions for mechanical engineer, marine engineer, engineer (junior grade), engineering aid (aeronautical), engineering draftsman, and aeronautical engineer, which are still open, were listed on page 772 of MECHANICAL ENGINEERING for October, 1940.

GRADUATE MECHANICAL OR CHEMICAL ENGINEER, 25–33, with about 4 years' experience since graduation in heat-transfer-equipment engineering, to figure heat-transfer surfaces and design heat-exchange equipment, welded pressure vessels, etc.; also to select proper metal materials; cost estimating and some laboratory experimental work. New England. Y-6604.

PROCESS ENGINEER, 25–35, graduate mechanical engineer, with 3 to 5 years' experience in keeping work going on established processes in light metal manufacturing. Salary, $180–$250 a month. New England. Y-6610.

GRADUATE MECHANICAL ENGINEER with at least 10 years' experience in procurement and purchasing of small machine tools. Must know machine tools, have good knowledge of purchasing and markets. Salary open. New England. Y-6611.

MECHANICAL ENGINEER, about 30, of research type, with some knowledge of metallurgy and effect of heat on metals, particularly in aluminum. Must have production experience as he will be called upon to direct metallurgical department, working out methods, procedures, and processes in plant. Salary, from $250–$300 plus profit, depending upon qualifications. Northern Ohio. Y-6621-R871C.

INDUSTRIAL AND PROCESS ENGINEER, 30–40, with knowledge of machine tools, hydraulic presses, welding, rough assembly work in steel-fabricating plant. Must know methods, etc. Experience in steel-fabricating plant important. Salary open. Northwestern Pennsylvania. Y-6625.

SALESMAN for seamless tube and pipe mill. 30 or younger. Technical college training preferred with some steel-product sales experience. Supply full particulars, experience, and training by letter in own handwriting, with recent photograph. Y-6653.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after November 25, 1940, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ADAMS, LEO, Brooklyn, N. Y.
ATTWOOD, JOHN G., Oak Park, Ill.
BRUNSON, LEONARD J., Dallas, Tex.
BUSH, GEO. F., Washington, D. C.
COGGESHALL, CLAYTON S., Schenectady, N. Y. (Rt)
COOPER, LEMUEL B., Seattle, Wash.
COWAN, A. V., Elizabeth, N. J.
DOWDEN, E. V., Boston, Mass.
EGRY, C. ROBT., Notre Dame University, Ind.
FLYNN, ROLAND W., New York, N. Y. (Rt & T)
GARWOOD, JOHN LESLIE, Toledo, Ohio
GRANBERG, BENGT R., Rockford, Ill.
HANSEN, EINAR T., Madison, Wis. (Rt & T)
HART, JOHN J., Watervliet, N. Y.
HUBER, ALFRED L., Brooklyn, N. Y.
HYLAND, W. L., Boston, Mass.
KEGO, ROBT., New York, N. Y.
KOUSNETZOFF, VALERIEN P., Chicago, Ill.
LAYFIELD, ELWOOD B., Los Angeles, Calif.
LEWIS, HAROLD S., Chicago, Ill.
MILLER, ERNEST F., Lansdowne, Pa. (Rt & T)
NEE, RAYMOND M., Boston, Mass.
PITMAN, W. ANDREW, Alliance, Ohio
RAND, I. J., Indianapolis, Ind.
ROCKETT, HAROLD C., Rye, N. Y. (Rt)
SCHWARTZ, JOS. WM., North Braddock, Pa.
SEVERN, HARRY A., Baltimore, Md. (Re)
SHAW, JOHN F., Los Angeles, Calif.
SIMMONS, EDW. E., JR., Pasadena, Calif.
SURGENT, LOUIS V., Whitestone, L. I., N. Y.
WALKER, CHAPMAN J., Schenectady, N. Y.
WAUTERS, JOHN W., Allenhurst, N. J.
WETZEL, IRWIN T., Iowa City, Iowa
WILLIS, BURTON C., JR., Drexel Hill, Pa.
ZELL, A. W., Wilmington, Del.

CHANGE OF GRADING

Transfers to Fellow

BLISS, COLLINS P., New York, N. Y.
COLE, EDW. S., Upper Montclair, N. J.
COLVIN, FRED H., Point Pleasant, N. J.
EBERHARDT, FREDK. L., Newark, N. J.
HERBERT, FREDK. D., Upper Montclair, N. J.
HOBART, FRANK G., Beloit, Wis.
HOLZBAUR, F. J., Sugar Creek, Mo.
KINGSBURY, ALBERT, Greenwich, Conn.
MONROE, WM. S., Chicago, Ill.
ROE, JOS. W., Southport, Conn.
SULLIVAN, GEO. L., Santa Clara, Calif.

Transfers to Member

ALLEN, DONALD PARSONS, Troy, N. Y.
BAILEY, BRUCE L., Chippawa, Ont., Can.
BERNITT, ELMER W., Kenosha, Wis.
CASSELL, CHAS. W., Westminster, Md.
CLINEDINST, WM. O., Pittsburgh, Pa.
COOPER, ALBERT H., Blacksburg, Va.
DISHINGTON, HERMAN, Pittsburg, Calif.
ERICKSON, EDW. A., Brooklyn, N. Y.
GIBBS, F. O., Greensboro, N. C.
GUTHRIE, ALBERT N., Ottawa, Ill.
KAYES, WM. J., Ottawa, Ont., Can.
MACGREGOR, CHAS. W., Belmont, Mass.
MASON, MARTIN A., Washington, D. C.
SCHICK, D. FREDK., JR., Philadelphia, Pa.
SMITH, GEO. L., Peoria, Ill.
WEBER, ALBERT M., Wenonah, N. J.
WHITEHURST, JOHN C., Spartanburg, S. C.
WOODSON, RILEY D., Kansas City, Mo.
YELLOTT, JOHN I., JR., Chicago, Ill.

A.S.M.E. Transactions for October, 1940

THE October, 1940, issue of the Transactions of the A.S.M.E., contains the following:

Successful Mechanical Atomization of Fuel Oil Heavier Than Bunker C, by G. G. Martinson
The Analogy Between Fluid Friction and Heat Transfer, by B. A. Bakhmeteff
Pump Discharge Valves on the Colorado River Aqueduct, by R. M. Peabody
Cavitation of Hydraulic-Turbine Runners, by R. E. B. Sharp
Combined Tension-Torsion Tests on a 0.35 Per Cent Carbon Steel, by E. A. Davis
The Engineering Method in Management, by A. I. Peterson
Fuels for Diesel Engines in Marine Transportation, by W. F. Joachim and H. V. Nutt
Superheat Control and Steam Purity in High-Pressure Boilers, by Martin Frisch
Properties of Hydrogen Mixtures, by A. W. Brunot
Experimental Drying, by D. L. Cooper and A. L. Wood
Heat Transfer to Falling-Water Films, by W. H. McAdams, T. B. Drew, and G. S. Bays, Jr.
Temperature Distribution and Sources in the Conventional Railway Journal Box, by E. S. Pearce

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

AP RHYS PRYCE, MERVYN A., June, 1940
BEHREND, ERNST R., September 22, 1940
BRECKENRIDGE, LESTER P., August 22, 1940
BUENTING, OTTO W., July 27, 1940
CHARLES, CARL L., September 12, 1940
CULVER, EDWARD P., August 21, 1940
DAVIS, CHARLES C., September 3, 1940
EMSWILER, JOHN E., September 23, 1940
ERNSBERGER, MILLARD C., January 25, 1940
FRANKLIN, BENJAMIN A., June 16, 1940
HASKELL, GEORGE O., July 11, 1940
JACOBUS, A. B., July 20, 1940
LOVEJOY, FRED P., February, 1940
MACCHESNEY, H. GORDON, September 13, 1940
MASON, WILLIAM H., AUGUST 24, 1940
MCKAY, WILLIAM M., September 20, 1940
NORCROSS, J. ARNOLD, August 19, 1940
ROTHSCHILD, WILBUR G., April 29, 1940
RUGG, HARRY M., July, 1940
STEVENS, GEORGE D., April 8, 1940
UEBELACKER, CHARLES F., September 17, 1940
UNDERWOOD, ROBERT C., September 16, 1940
VINTEN, ERNEST S., April 13, 1940
WAREAM, CHARLES E., May 29, 1940
WILLIAMS, FREDERIC S., April 14, 1940
WOODROW, HARRY R., August 12, 1940
YOUNG, WILLIAM V., July 6, 1940

Engineering Societies Building,
29 West 39th St., New York, N. Y.,
Headquarters of the A.S.M.E.

Program

SIXTY-FIRST

A.S.M.E. Annual Meeting

HOTEL ASTOR · · · NEW YORK, N. Y.

(Times Square, Broadway — 44th to 45th Street)

December 2 to 6, 1940

• Hotel Astor, located directly on Times Square, in here all functions of the 1940 Annual Meeting are being held

Guide to

14TH NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING

GRAND CENTRAL PALACE

(Lexington Ave., 46th to 47th St.)

NEW YORK, N. Y.

December 2 to 7, 1940

Program for A.S.M.E. Sixty-First Annual Meeting

New York, N. Y., December, 2–6, 1940

MONDAY, DECEMBER 2

9:30 a.m.

Council Meeting
Sections Delegates' Meeting
Division Delegates' Meeting

12:30 p.m.

Council, Sections Delegates and Professional Divisions Delegates—Luncheon

2:00 p.m.

Business Meeting

6:30 p.m.

Work Standardization—Management Dinner

8:00 p.m.

Machine Line Production of Aircraft Materials

Discussion Leaders:
Engines, R. F. Gagg
Aircraft Parts, Preston Bassett
Aeronautic Progress Report (by title)

Elasticity and Vibration

Analysis of Clamped Rectangular Plates, by Dana Young[1]
The Effect of Foundation Stiffness on the Resonant Frequencies of Rotating Machines—Determined by Nonrotating Models, by Edwin H. Hull[1]
Transient Torques in Induction-Motor Drives, by A. M. Wahl[1]

Fuels (I)

Wood-Burning Space Heaters, by L. E. Seeley and Frederic W. Keator[1]
The Significance of Coal-Ash Fusing Temperature in the Light of Recent Furnace Studies, by E. G. Bailey and F. G. Ely[1]

Machine Shop Practice (I)

Lubrication of General Electric Steam Turbines, by C. Dantsizen[1]
Program for Industrial Lubrication, by Virgil M. Palmer and Charles L. Pope[1]

Work Standardization

Ratio Delay Study, by R. L. Morrow[1]
A Study of the Development of Skill During the Performance of a Factory Operation, by Ralph M. Barnes, James S. Perkins, and J. M. Juran[1]

Boiler Feedwater Studies

Silica in High-Pressure Boiler Waters, by Harold Farmer
Silica Removal, by H. L. Tiger
Absorption Process for Removal of Soluble Silica From Water, by L. Drew Betz, Chas. A. Noll, and John J. Maguire

[1] To be preprinted for 1940 Annual Meeting.

TUESDAY, DECEMBER 3

9:30 a.m.

Applied Mechanics

An Eddy-Current Method of Flaw Detection in Nonmagnetic Metals, by Ross Gunn[1]
Temperature Effects in a Laminar Compressible-Fluid Boundary Layer Along a Flat Plate, by H. W. Emmons and J. G. Brainerd[1]
An Extension of the Photoelastic Method of Stress Measurement to Plates in Transverse Bending, by J. N. Goodier and G. H. Lee[1]

Metals Engineering

The Production of Seamless Tubes by the Combined Effects of Cross-Rolling and Guide Disks, by W. Trinks[1]
Latest Developments in Extrusion and Extrusion Presses, by O. B. Cudebec

Industrial Instruments

Thermometric Time Lag, by Rudolf Beck[1]
Asymptotic Reset Controllers, by R. P. Lowe and E. S. Smith (by title)

Fuels (II)

Continuous Heat Balance Control of Boiler Room Operation, by B. S. Murphy[1]
Flow Processes in Underfeed Stokers, by Martin A. Mayers[1]

Machine Shop Practice (II)

Surface Quality of an S.A.E. 3140 Steel, by O. W. Boston and W. W. Gilbert[1]
An Analysis of the Milling Process, by Ercole M. Martellotti[1]

Mathematical Statistics

A Critical Appraisal of Statistical Methods in Industrial Management, by Lewis C. Young[1]
Criteria in Simple Quality Control, by Knox McIlwain[1]
Experience With Statistical Quality Control, by R. E. Warehan

12:30 p.m.

S.P.E.E. Luncheon

2:00 p.m.

Dust Collection

Calculation of Cyclone Pressure Drop, by Franklin Miller and Marcel Lissman[1]
Recent Developments of the Cyclonic-Spray Gas Scrubber, by Robert V. Kleinschmidt and A. W. Anthony, Jr.[1]

Power—Fuels

Steel Encased Settings for Modern Steam-Generating Units, by M. H. Kuhner[1]
Some Particulars of Design and Operation of a Twin-Furnace Boiler, by John Blizard and A. C. Foster[1]

TUESDAY (*Continued*)

2:00 p.m.

Applied Mechanics—Oil and Gas Power

Effects of Surface Finish on Journal-Bearing Performance, by J. T. Burwell, Jr., J. Kaye, D. W. van Nymegen, and D. A. Morgan[1]
Flexible Couplings for Internal-Combustion Engines, by J. Ormondroyd[1]

Petroleum—Industrial Instruments and Regulators

Mathematics of Surge Vessels and Automatic Averaging Control, by G. A. Philbrick and H. L. Mason[1]
Combustion Explosions in Pressure Vessels Protected With Rupture Disks, by Merl D Creech[1]

Materials-Handling Operations in Industrial Plants

Economics of Materials-Handling Methods in Industrial Plants, by H. C. Keller

8:00 p.m.

Smoker

WEDNESDAY, DECEMBER 4

9:30 a.m.

Power

A New Steam Engine and Boiler, by S. L. G. Knox and John I. Yellott[1]
A Study of Circulation in High-Pressure Boilers and Water-Cooled Furnaces, by John Van Brunt[1]

Lubrication (I)

Relationship of Viscosity to Rate of Shear, by L. J. Bradford and F. J. Villforth, Jr.[1]
The Multiple Oil-Film Radial Bearing, by Gustave Fast
Flow Properties of Lubricants Under High Pressure, by A. E. Norton (deceased), M. J. Knott, and J. R. Muenger[1]

Mechanical Springs

Recommended Code of Procedure for Fatigue Testing of Hot-Wound Helical Compression Springs, by C. T. Edgerton[1]
Effect of Temperature on Coiled Steel Springs Under Various Loadings, by F. P. Zimmerli[1]

Rolling and Plasticity

Equiareal Pattern of Stress Trajectories in Plane Plastic Strain, by M. A. Sadowsky[1]
High-Speed Tension Tests at Elevated Temperatures, Part II, by A. Nádai and M. J. Manjoine

Port and Terminal Handling

Materials-Handling Methods at Ports and Terminals, by Harry E. Stocker

WEDNESDAY (*Continued*)

9:30 a.m.

Industrial Marketing

Market Analysis From Management Standpoint, by Robert T. Kent[1]
Merchandising of Industrial Goods, by Willard Chevalier

Textile (I)

Water Supplies for the Textile Industries, by Sheppard T. Powell and H. E. Bacon
The Treatment of Textile Wastes, by Harold B. Gotaas[1]

12:30 p.m.

Textile Luncheon—Organization Meeting
Development and Use of Anti-Friction Bearing in Textile Industry, by R. H. DeMott
Student Luncheon

2:00 p.m.

Lubrication (II)

Power Losses in High-Speed Journal Bearings, by F. C. Linn and D. E. Irons[1]
Friction in Ball Bearings, by H. Styri

Ammunition

Titles of papers and authors to be announced later

Management

A Case Study of Electrical Rates and Service in a Suburban Community, by Gregory M. Dexter[1]

Power—Applied Mechanics

Solving Pipe Problems—A Mechanical Method for Cases Involving Temperature Expansion, by F. M. Hill[1]
Condenser Tubes and Their Corrosion, by C. W. E. Clarke and A. E. White[1]
Flow of Saturated Water Through Throttling Orifices, by Max W. Benjamin and John G. Miller[1]

Process—Safety

Safety Features in Rubber and Plastic Industries, by J. Milward
Designing Safety Features Into Operation of Punch Presses, by Wendell Nelson
Mechanical Lanes of Safety, by Harry Duffus

Textile (II)

Textile Drying, by Fred Kershaw[1]

Fluid Meters

The Annis Meter, by M. B. MacNeille and R. K. Annis[1]
Effect of Ambient Temperatures on the Coefficients of Venturi Meters, by W. S. Pardoe[1]
Discharge Coefficients of Long-Radius Flow Nozzles When Used With Pipe Wall Pressure Taps, by H. S. Bean, S. R. Beitler, and R. E. Sprenkle[1]
Calibration of Volumeters, by E. E. Ambrosius

6:30 p.m.

Banquet and Honors Night

[1] To be preprinted for 1940 Annual Meeting.

THURSDAY, DECEMBER 5

9:30 a.m.

Power—Boiler Feedwater

Problems of Boiler Feedwater Treatment at New High-Pressure Installation at Waterside Station, by Charles B. Arnold, Raymond T. Hanlon, and Julius Mindheim
A New Degasifying Steam Condenser for Use in Conductivity Determinations, by F. G. Straub and Elwood E. Nelson[1]

Training to Meet the National Emergency (I)

Training for National Defense, by A. A. Potter[1]
Training in Industry to Meet the National-Defense Program, by C. R. Dooley
Training College Graduates for the Aeronautic Industry, by R. R. Irwin and Jacob Kadushin

Heat Transfer (I)

The Radiation of Furnace Gases, by H. C. Hottel and R. B. Egbert[1]
Heat Transfer in Blast-Furnace Stoves, by George Akin

Hydraulics (I)

Kaplan Turbine Installations of the Tennessee Valley Authority, by George R. Rich and J. F. Roberts[1]
Turbine Discharge Metering at the Safe Harbor Hydroelectric Development, by J. M. Mousson[1]

Rubber and Plastics (I)

Corrosion-Resistant Phenolic-Resin Asbestos Compositions, by W. H. Adams[1]
Rubber Springs Under Compression Loading, by J. F. Downie Smith[1]

Dynamics of Vehicles

Notes on the Dynamics of Electric Locomotives, by B. S. Cain
Notes on the Dynamics of Angular Motions of a Ship, by N. Minorsky
Ride Characteristics of Modern Passenger Cars, by Robert Schilling and H. O. Fuchs

Railroad (I)

Progress in Railway Mechanical Engineering, 1939–1940, by E. G. Young[1]
Graphical Methods for Plotting Time-Speed-Distance Curves for Railway Trains, by A. I. Lipetz[1]
Train Acceleration With Steam Locomotives, by Lloyd B. Jones[1]

2:00 p.m.

Training to Meet the National Emergency (II)

Important Training Being Done at U. S. Navy Yard, by Captain C. W. Fisher
The New York State Education Departments' National-Defense Training Program at R.P.I., by William O. Hotchkiss and Stanley Wiltse[1]
Need for Training on College and Subcollege Levels as Seen by U.S.C.S. Commission, by E. J. Stocking

Heat Transfer (II)

Heat Transfer to Hydrogen-Nitrogen Mixtures Inside Tubes, by A. P. Colburn and C. A. Coghlan[1]

THURSDAY (*Continued*)

Remarks on the Analogy Between Heat Transfer and Momentum Transfer, by L. M. K. Boelter, R. C. Martinelli, and Finn Jonassen[1]
Vaporization Inside Horizontal Tubes, by W. H. McAdams, W. K. Woods, and R. L. Bryan[1]

Hydraulics (II)

The Development of the Automatic Adjustable-Blade-Type Propeller Turbine, by R. V. Terry[1]
Speed Regulation of Kaplan Turbines, by J. D. Scoville[1]

Rubber and Plastics (II)

The Creep of Natural and Synthetic Rubber Compounds in Shear, by Stuart H. Hahn and Ivan Gazdik
Notes on the Creep of Neoprene in Shear, by F. L. Yerzley
Annual Report of the Subdivision on Rubber and Plastics

Effect of Temperature on Properties of Metals

A High-Temperature Bolting Material, by A. W. Wheeler[1]
An Investigation of the Effect of Grain Size and Structure on the Suitability of Carbon-Molybdenum Steel Pipe for High Temperature Steam Service, by A. E. White and Sabin Crocker[1]
Progress Report on Creep of Tubular Specimens, Project No. 10, by F. H. Norton

Railroad (II)

Modern Objectives in Steam-Locomotive Design, by R. M. Ostermann[1]
A Fundamental Development in Suspension and Construction for Railroad Cars, by Paul K. Beemer, F. C. Lindvall, E. F. Stoner, and W. E. Van Dorn[1]

6:30 p.m. College Regions

8:30 p.m.

Symposium on Power in Ships

Marine Boilers: E. G. Bailey and L. M. Rakestraw
Marine Turbines: E. D. Dickinson and J. A. Davies
Marine Condensers: Paul Bancel and H. E. Carleton

Official Notice

A.S.M.E. Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held Monday afternoon, December 2, 1940, at 2:00 p.m. at the Hotel Astor, New York, N. Y., as a part of the Annual Meeting of the Society.

(*Signed*) C. E. DAVIES
Secretary

Progress Through Engineering Stressed at 1940 A.S.M.E. Annual Meeting, New York, N. Y., Dec. 2–6

More Than 100 Papers at 44 Technical Sessions; Smoker Planned; Special Symposium on "Power in Ships"

DEDICATED to the proposition that better living and greater industrial progress is possible through engineering, the sixty-first Annual Meeting of The American Society of Mechanical Engineers to be held in New York City, Dec. 2–6, 1940, with meeting headquarters at the Hotel Astor instead of the Engineering Societies Building, is expected to attract about 5000 engineers and executives from all parts of the United States and Canada. More than 100 technical papers on such specialized mechanical-engineering subjects as aeronautics, applied mechanics, fuels, hydraulics, metals and engineering, machine-shop practice, management, materials handling, petroleum, steam power, railroads, textiles, heat transfer, and process industries will be presented by leading experts in the field.

Symposium on "Power in Ships"

Attention is called particularly to the symposium arranged for Thursday evening at 8:30 p.m. on "Power in Ships." This will cover a period of about two hours with the first hour devoted to six speakers, with the time and subjects as follows: "Marine Boilers" will be discussed by E. G. Bailey and L. M. Rakestraw; "Marine Turbines" has been assigned to E. D. Dickinson and J. A. Davies; "Marine Condensers" to Paul Bancel and H. E. Carlton. An open discussion will follow.

Because of the present international defense program this symposium should be of especial interest not only to members of the A.S.M.E. but also to those of the Naval Architects and Marine Engineers and the A.I.E.E. The speakers are men of wide reputation in the power field and undoubtedly this session will be one of the high spots of the Meeting.

Inspection Trips

W. G. Blake, chairman of the Plant Visits Committee, reports that in order to please every member, no matter what his specialty, trips are being scheduled to various kinds of industrial plants in and about New York City. Since so many members, having heard Maxwell W. Maxwell speak before their Local Sections, have expressed a desire to see the actual manufacture of locks and materials-handling equipment, a trip will be made to the Stamford, Conn., plant of the Yale and Towne Manufacturing Co. Every member will be happy to hear that arrangements are now being made to include a visit to the *S. S. America*, the largest ship ever built in an American shipyard. At the suggestion of the Oil and Gas Power Division, a trip will be made to a Diesel-engine plant in New York. Other points of interest to mechanical engineers to be included in the list of inspection trips are the American Airlines shops and hangars at La Guardia Airport, North Beach, N. Y., the new Sixth Avenue Subway (opening December 15), the East River-Midtown Tunnel and ventilating towers (opening in December), the new 35-mile Belt Parkway with its sodium lights, the new 1475-psi 925-F, 65,000-kw steam-power generators at the Waterside Station of the Consolidated Edison Company of New York, Inc., a large printing establishment, a food-processing plant, the New York factory of the American Can Company, and other industrial plants.

Informal Smoker

To replace the spot left vacant in the program by combining the ceremonies of Honors

(*Continued on page 852*)

Registration Fee for Non-Members at the 1940 Annual Meeting

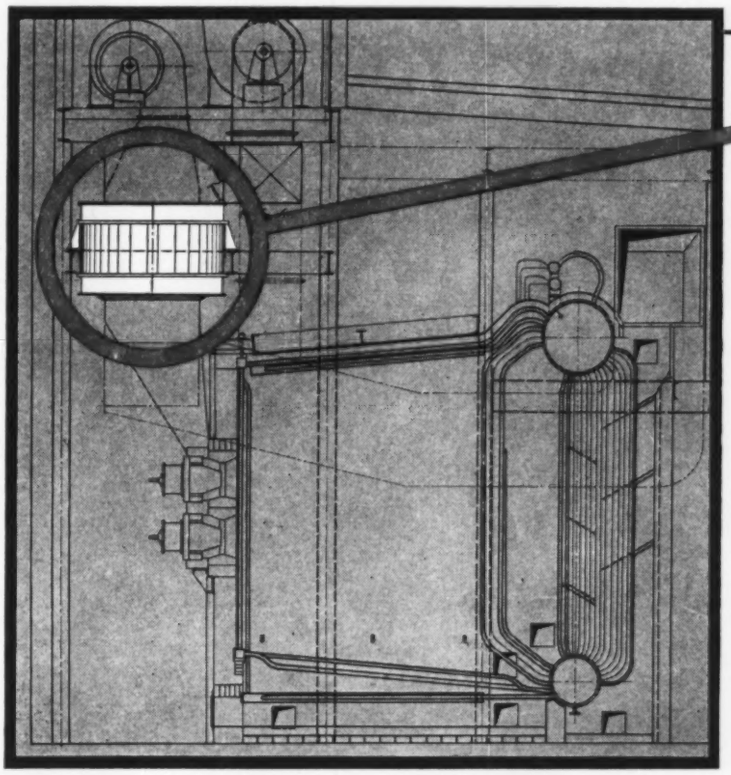
There will be a registration fee of $2 for nonmembers attending the 1940 A.S.M.E. Annual Meeting. For nonmembers wishing to attend just one session the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests may avoid this fee by writing to the Secretary of the Society before November 25 asking for a guest-attendance card for the Annual Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member*.

THE MAIN PUBLIC LIBRARY, FIFTH AVENUE AT 42ND ST., NEW YORK, N. Y.
(Well worth visiting while in New York at the A.S.M.E. Annual Meeting in December.)

It Goes Double for Scott

At Scott Paper Company, Chester, Pa., one Ljungstrom Air Preheater has served since 1935; another went in on new boiler in 1938



In the manufacture of paper products, efficient steam generation is a vital factor. The Scott Paper Company has made it a point to keep "ahead of the game" with modern, high efficiency power plant units. In a steam generating unit of 125,000 lb. per hr. capacity purchased in 1935, a Ljungstrom was selected to preheat incoming air to 460 deg. F.

In 1938, on another 125,000 lb. per hr. unit built by another boiler manufacturer, the call again went to Ljungstrom. In this unit (left) gases enter the preheater at 745 deg., leave at 373 deg., heating combustion air to 489 deg. F. To date, service records on both units have justified the consistent choice.

The Modern Ljungstrom Air Preheater

To the recognized thermal superiority of the *continuous regenerative counterflow* principle, the *modern* Ljungstrom Air Preheater now adds an extra measure of mechanical surety. The resulting clear margin of advantage for the Ljungstrom in any economic balance calling for high levels of heat recovery is indicated by today's installation records: Today more Ljungstroms are being installed in power plants than all other types of air preheaters combined.

Engineering evidence which confirms this margin of advantage — evidence which shows how constructional improvements have stepped up present-day performance—is available on request. It will be of noteworthy economic interest to engineers and other executives concerned with power-plant design or responsible for operating efficiency and availability. May we send a copy?

THE AIR PREHEATER CORPORATION

60 East 42nd Street **New York, N. Y.**

and Awards Night with the Annual Banquet on Wednesday evening, the Committee on Meetings and Program has delegated O. B. Schier, 2nd, and a committee to arrange for an informal smoker for Tuesday evening, Dec. 3. Following a buffet supper, the members will be regaled by star entertainers from the stage and radio. Of course there will be impromptu entertainment by the members themselves, ably assisted by a master of ceremonies.

Annual Banquet

The big social affair of the 1940 Annual Meeting will be the banquet on Wednesday evening, Dec. 3, in the grand ballroom of the Hotel Astor. To enable every engineer and manufacturing executive to attend, the Power Show will close that evening at 6 p.m. Officers for 1941 recently elected by a letter ballot of the 15,000 members (see page 837) will be introduced. Another traditional function will be the introduction of all members present who have been in the Society 35 years or more. Those with membership records of 50 years will be given 50-Year gold buttons. There will be two outstanding addresses, one by President Warren H. McBryde, and the other by one of the leading members of the Advisory Commission to Council of National Defense.

A.S.M.E. Awards for 1940

One of the most impressive ceremonies of the banquet though lasting only 20 minutes, will be the presentation of A.S.M.E. Honors and Awards for the year 1940. Prof. Joseph W. Roe, chairman of the Board of Honors and Awards, will present each recipient to President McBryde, who will award the certificates and medals. The engineers recently selected by the Board and Council of the A.S.M.E. for these honors include:

A.S.M.E. Medal to Charles F. Kettering, A.S.M.E. member since 1915, and president, General Motors Research Laboratories, Detroit, Mich., for his many inventions and developments in the automotive and other fields.

GENERAL VIEW OVERLOOKING WASHINGTON SQUARE IN NEW YORK CITY

(Looking north from above the south edge of the Square with the Washington Arch, No. 1 Fifth Avenue Building, and the Empire State Building in the background.)

THE CLOISTERS IN FORT TYRON PARK, NEW YORK CITY

(A branch of the Metropolitan Museum of Art. This unique museum has within its four acres a complete medieval monastery.)

Holley Medal to Edward H. Armstrong, professor of electrical engineering, Columbia University, New York, N. Y., for his invention of "frequency modulation" and other radio circuits.

Worcester Reed Warner Medal to William B. Gregory, past vice-president of the Society, and research engineer, F.W.A., Washington, D. C., for his contributions to permanent engineering literature.

Melville Medal to Carl A. W. Brandt, chief engineer, Superheater Co., New York, N. Y., for his paper, "The Locomotive Boiler," which was presented at the 1939 Annual Meeting and published in Transactions of the A.S.M.E., July, 1940.

Honorary Memberships to William L. Abbott, past-president of the Society, Chicago, Ill.; James A. Seymour, retired, Auburn, N. Y.; Arthur M. Greene, Jr., past vice-president of the Society, and dean emeritus of the school of engineering at Princeton University, Princeton, N. J.; Robert W. Angus, past vice-president of the Society, and professor and head of the department of mechanical engineering at the University of Toronto, Toronto, Ontario, Canada; and Albert Kingsbury, 1931 A.S.M.E. Medalist, and president of Kingsbury Machine Works, Philadelphia, Pa.

A.S.M.E. Junior Award to R. E. Newton, junior A.S.M.E., and instructor, Washington University, St. Louis, Mo., for his paper, "A Photoelastic Study of Stresses in Rotary Disks," presented at the 1939 Annual Meeting and published in the *Journal of Applied Mechanics*, June, 1940.

Pi Tau Sigma Medal Award to George A. Hawkins, member A.S.M.E., and associate professor, teaching research, Purdue University, Lafayette, Ind., as the outstanding young mechanical engineer of 1940.

Charles T. Main Award of $150 to Frank De Pould, student member A.S.M.E., Case School of Applied Science, Cleveland, Ohio, for his paper, "What Has Been the Effect of Technological Advance on Employment."

Postgraduate Student Award to G. W. Shepard, Jr., student member A.S.M.E., Princeton University, Princeton, N. J., for his paper, "An Automatic Mechanical Control for Synchronizing Prime Movers."

Undergraduate Student Award to Edward D. Rowan, student member A.S.M.E., Oregon State Agricultural College, Corvallis, Ore., for his paper, "Powder Metallurgy."

Photographic Exhibit

All during the week of the Annual Meeting, there will be an exhibition in the Hotel Astor of technical and nontechnical photographs sent in by A.S.M.E. members and their friends. According to George G. Hyde, chairman of the committee arranging this Fifth Annual A.S.M.E. Photographic Salon, it will be the largest and best ever held. A group of judges, including the photographic editors of the New York newspapers, will pick the twelve outstanding prints submitted and award trophies. There will be special trophies for members, nonmembers, juniors, and student members. Complete rules and details of the salon will be found on page 854.

Library Exhibit

Even though the meeting this year is not being held in the Engineering Societies Building, there will be a special exhibit of books, periodicals, and charts in the Engineering Societies Library. Also to be shown will be engineering publications issued in the early days of printing, together with some of those

(*Continued on page 854*)

RESISTS WEAR AND CORROSION

CUTS LUBRICATING COSTS TO A MINIMUM

Lubriplate lubricants have been used for years in the aviation industry on numerous exacting applications with marked success. In the lubrication and protection of controllable pitch propellers, landing gears, magnetos, etc., Lubriplate has set up quite a record in reduction of friction, wear, power loss—and in protecting the various parts against the ravages of rust and corrosion. Lubriplated airplane parts last longer.

And just as Lubriplate has solved the tough lubricating problems of the air—so has it solved the "tough ones" on the ground! Take the Falls Yarns Mills in Woonsocket, R. I., for example. Writes the manager, "We used to buy new bearings about every month. Since we adopted Lubriplate, over five years ago, we have had to replace only one ball bearing race. Our consumption of lubricant is so small that if we had to pay a much higher price for Lubriplate—we could still afford to use it!"

No matter what your lubrication problem, we claim that Lubriplate will solve it! And to back our claim we make this offer: Give us your lubrication problems. We'll give you a sample of Lubriplate—enough to test in your own plant, under your own operating conditions. Then you be the judge!

7 QUICK FACTS

1. *Lubriplate produces a wear-resisting film on working surfaces.*
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6. *Lubriplate is cheapest—a little goes a long ways.*
7. *Lubriplate is available in fluid and grease types for every need.*

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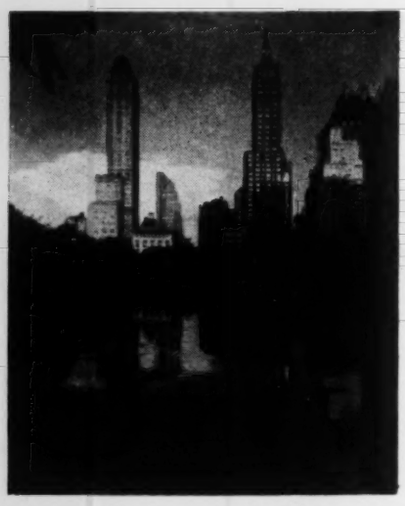

IN CENTRAL PARK IN NEW YORK CITY
(The little lake, the Plaza corner with skyscrapers in background.)

published recently which may be of interest to mechanical engineers.

As usual, Dr. Harrison W. Craver will have his "welcome" mat outside his office door to encourage old and new friends to drop in and say hello. If any member brings along a 35-mm camera, he can use without charge the new photocopying stand installed recently in the Library. And for the first time in the history of this engineering institution, members will be able to borrow and take home practically any book for a small nominal fee.

Power Show

All during the week of the A.S.M.E. Annual Meeting, the 14th National Exposition of Power and Mechanical Engineering will be in progress at Grand Central Palace. According to the sponsors of the show, the International Exposition Company, more than 270 leading manufacturers of power-production equipment will be represented. A.S.M.E. members are invited to attend by the company.

Other Events

Wednesday, Dec. 4, will be Students Day at the Annual Meeting of the A.S.M.E. Following a special student members' session in the morning, the annual luncheon of this group will be held in the Hotel Astor. Special inspection trips for the boys are being scheduled for the afternoon. Other events include meetings of more than 100 A.S.M.E. technical, research, and standing committees, informal dinners and luncheons, and the college reunions on Thursday evening, Dec. 5.

Women's Program

The program in more complete detail for the visiting women, including shopping trips, a special dinner on Tuesday evening, Dec. 3, visits to a modernistic furniture factory, radio broadcasting stations, the *S.S. America*, and historic New York spots, and informal social functions, is being prepared by a committee composed of members of the New York Section of the Woman's Auxiliary to the A.S.M.E.

Fifth Annual A.S.M.E. Photographic Exhibit to Be Held During 1940 Annual Meeting

Technical and Nontechnical Prints May Be Submitted by Members and Friends on or Before November 27

THE Photographic Group of The American Society of Mechanical Engineers invites members and their friends to participate in the Fifth Annual Photographic Exhibit to be held at the Hotel Astor, New York City, in conjunction with the 1940 Annual Meeting of the Society, Dec. 2–6. As in previous years, both technical and nontechnical subjects will be acceptable. Entry blanks may be obtained from A.S.M.E. headquarters.

Outstanding prints, as selected by a board of judges consisting of nationally famous photographers, will be eligible for valuable trophies. As an added incentive, the best of the technical photographs, prize winners, and others, will be reproduced in MECHANICAL ENGINEERING.

THE NEW THEODORE ROOSEVELT WING AND OLDER BUILDING OF MUSEUM OF NATURAL HISTORY BEYOND
(Looking down Central Park West from 81st Street, New York City.)

Any Number May Be Submitted

Any number of prints may be submitted, although the Photographic Group reserves the right to select and limit the number of prints actually hung, depending on the space available. However, according to present indications, there will be plenty of space this year to take care of all prints. Unless specifically directed otherwise in writing, the committee arranging the exhibit assumes that the photographer in submitting his prints gives it permission to allow the free reproduction of any print by MECHANICAL ENGINEERING.

All pictures sent in must be accompanied by an entry blank and should be mounted on 16 × 20-in. light-colored cards. It is also suggested that each photograph be submitted with the following data attached: Title, where taken, name of photographer, his address, camera, lens *f* stop, shutter speed, light conditions, type of film or plate, developer, and printing-paper information, if available. On the back of each print should be written the name and address of the member or friend submitting it.

Prints should be sent in on or before Nov. 27 to the A.S.M.E. Photographic Exhibit Committee, 29 West 39th Street, New York, N. Y. They will be returned as soon as possible after the close of the exhibit, except where prints are retained for subsequent reproduction in MECHANICAL ENGINEERING. These will be returned later by the editorial department.

Wrap Securely

To facilitate the handling of prints submitted, they should be protected with corrugated cardboard and securely wrapped. To save postage, the photographs should be sent parcel post, insured if desired. Postal regulations forbid the enclosure of any letter or entry blank in the package but permit the attachment of it to the outside of the wrapping in a stamped envelope. Fifty cents should be enclosed as an entry fee and ten cents per print to cover return postage and insurance.

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Cushing[1]

ST. PAUL'S CHAPEL—OLDEST CHURCH EDIFICE IN MANHATTAN
(Here George Washington attended services immediately after his inauguration as first president of the United States.)

[1] Views of New York City in this Section are all by C. P. Cushing.

MULTIPLE RETORT *Stoker* BY C-E

When the multiple retort stoker is the solution of your coal burning problem, here's your *answer* provided by C-E from the most complete line of stokers offered by any manufacturer. The story of this stoker began nearly 10 years ago when C-E decided to utilize its many previous years of multiple retort stoker experience to develop a superior design. The resulting stoker is illustrated above with all the detail refinements that have been incorporated up to the present time. We believe this 1940 C-E Multiple Retort Stoker represents a higher degree of mechanical perfection than ever achieved in multiple retort designs. The high efficiencies being obtained over a wide range of ratings, in conjunction with extremely low operating and maintenance costs, are a true reflection of the design and construction advantages which mark this stoker as "the buy" in its field. A new catalog will shortly be issued. Write for a copy.

A-529

C-E

COMBUSTION ENGINEERING CO., INC.

200 MADISON AVENUE, NEW YORK, N. Y.

CANADA: COMBUSTION ENGINEERING CORPORATION, LTD., MONTREAL

THE SAME OLD R.P.Ms BUT..

LARGER SPROCKETS *PLUS* MORSE *Silent* CHAIN

EQUALS MILE A MINUTE CHAIN SPEEDS *AND* GREATER CAPACITY AT LOWER COST

IT IS A simple matter with Morse Chain! Simply by using larger sprockets with more teeth, jumping chain speeds up to mile-a-minute, Morse Chain's power transmitting capacity is multiplied.

This treatment results in slip and wasted power in other types of drives, but not in Morse Chain drives. The silent chain actually utilizes centrifugal force to produce better contact with sprocket teeth, and more even load distribution.

Morse Silent Chain, operating at mile-a-minute speeds, is so silent you scarcely hear it. There's no noise of strain or overloaded bearings. Load capacity rises tremendously with chain velocity. Wear is at a bare minimum, because the load is distributed over multiple chain and sprocket teeth. Chain width greatly reduced. Efficiency is 99.4% for the life of the drive with high velocity silent chain.

Morse High Speed Silent Chain drives can probably work profitably for you. Applicable to speeds from 400 to 4000 r.p.m. Ask the Morse man in your territory for full information. Or write Morse, Ithaca.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

A.S.M.E. GUIDE

14th National Exposition of Power and Mechanical Engineering

Grand Central Palace, New York, N. Y. December 2nd to 7th, 1940

THIS "Guide to the National Power Show" contains a List of Exhibitors supplied by the International Exposition Co. who manage the Show. It appears on pages 18, 20 and 22. Its accuracy in detail is not final because of inevitable additions and changes between the date of going to press and the opening of the Show. In this list the numbers of the booths occupied are given and by referring to the floor-space diagrams shown on those pages, a user of this Guide can readily locate any booth in which he is interested. The Exposition will be open from Monday, December 2nd to Saturday, December 7th, inclusive. Opens Monday at 2 p.m. and then daily from 12 noon to 10:30 p.m.; Wednesday and Saturday until 6 p.m.

Three entire floors of the Grand Central Palace will be devoted to exhibits of equipment and products which have been designed to meet current needs. Actual equipment, live demonstrations, activated displays, dioramas, giant illustrations, graphs, charts, etc., will be utilized to show products so that they may be easily inspected and attention drawn to their new and important features. Competent men from exhibitors' technical staffs will answer

visitors' questions, demonstrate products, and explain how principles may be applied to the specific problems which confront the inquirer.

The Exposition this year is more comprehensive than in the past and will include the products of over 275 exhibitors. It is a review of progress that will give the visitor up-to-the-last-minute knowledge of what is being used to advantage in his particular field.

The development of indicating and recording instruments is fully exemplified and all manner of gages, meters and special testing instruments are displayed, many offering new applications of time-tested principles, others introducing new and ingenious applications incorporating materials which until recently were scarcely more than laboratory curiosities. Many new materials are brought into service—new alloys having more favorable characteristics—and new designs adapted to changing needs. An extensive display of one of the newer rubber-like synthetics will be shown. Among other new products shown will be condenser tubes formed of a new copper alloy.

One exhibitor will display an automatic boiler water level control system designed to maintain the level in two or more boilers simultaneously. Materials used in construction and replacement under the boiler include refractory products in great variety. The array of piping materials,

valves, fittings and appliances will be as usual very comprehensive. Modernized pipe cutting and threading machines will also be shown. Among portable tools will be exhibited belt-sanders, grinders hand-saws, etc. There will be a number of displays of centralized lubricating systems, one of which is designed to handle very heavy greases. There will be a good variety of material handling devices at this year's Show, including electric hoists, lift trucks and portable elevators. The Show will permit a review of many of the different appliances of power drives, such as slow-speed and variable-speed electric motors, variable-speed mechanical transmissions, speed reducers, variable-speed belt drives with adjustable diameter sheaves, flat-belt drives with automatic tension control governed by the load.

One exhibitor will display automatic frictionless regulating devices for the control of all liquids and most gases. Another specializes in automatic fluid pressure

control specialties; temperature and level controllers are the specialty of still another. Automatic instruments for indicating, recording, controlling air, fuel and even analyzing exhaust gases, will be seen. A working model in glass of a steam trap will reveal how air and dirt are handled automatically as well as condensate. Here, will be shown a new development for replacing gaskets in pipe lines; there, miniature equipment demonstrating a method for forming a solid metallic sleeve around a shaft from a special packing material when subjected to pressure of the gland. Full-flowing pressure filters will be among the exhibits; also pipe cleaning machines and tools.

A new type of vacuum cleaner will be on view, as well as several types of blowers. Among the more dynamic displays will be an automatic machine for filing and grinding several types of saws. Another exhibit will feature a vibrating machine, demonstrating the ability of all-metal,

flexible tubing to withstand vibration and movement while under pressure. A third will show working demonstrations of flexible metal hose in a different way.

"Stretching" the capacity of the existing power plant, will be demonstrated by larger blowers to replace smaller ones, induced draft systems to be installed to supplement forced draft; improved methods of feed-water heating, more efficient systems of water-level control; flowmeters to monitor the steam supply. Heavy valve replacements and streamlined pipe layouts will be needed when pressures are stepped up. Variable speed drives for stokers, blowers, mechanical scrubbers and various other applications around the power house are shown.

Many new devices will be shown in the line of piping, fittings and valves. There is also the great array of pipe-threaders. One of the new centrifugal pumps shown is so designed that its rotor may be removed from the casing without disturbing inlet or discharge pipe connections, or altering the alignment of pump and motor, which are mounted on a common base. A new low-current arc welder will be shown which can be used with currents as low as 5 amperes.

As in previous years, the National Power Show is being held during the same week as the A.S.M.E. Annual Meeting; and a special invitation is extended to all A.S.M.E. members to attend. Tickets of admission can be had without charge at Society Headquarters.

A.S.M.E. members are especially invited to visit the A.S.M.E. Booth (No. 80) on the main floor near front entrance, where information regarding A.S.M.E. activities and publications will be available.

Fourteenth National Exposition of Power and Mechanical Engineering

LIST *of* EXHIBITORS *and* FLOOR DIAGRAMS

Main Floor: Booths 1 to 95 **Second Floor: Booths 200 to 348** **Third Floor: Booths 401 to 569**

(Corrected to October 22, 1940 from list supplied by International Exposition Co.)

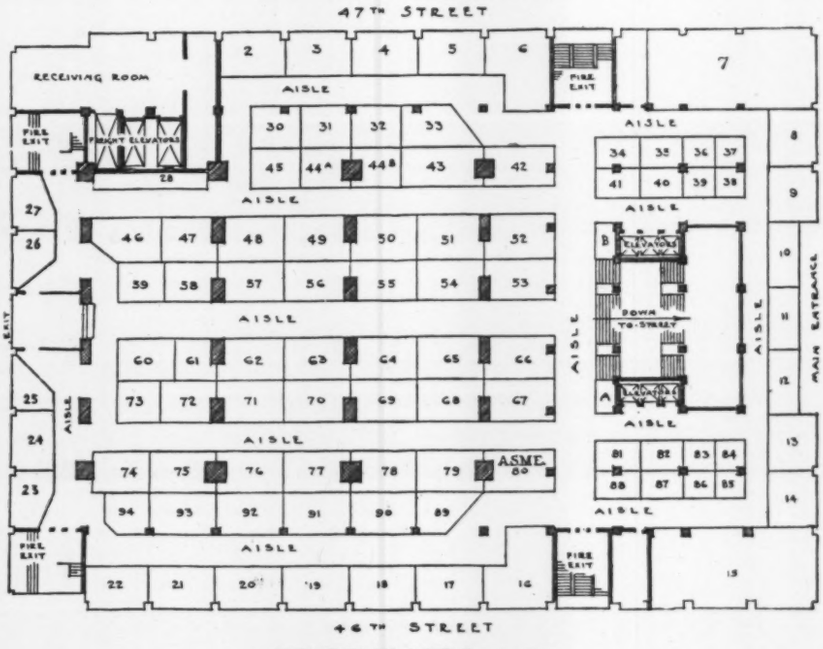
ALPHABETICAL LIST

Booth

A.S.M.E. Mechanical Catalog & Directory....80
29 W. 39th St., New York, N. Y.
Acheson Colloids Corp.....228, 229
1648 Washington Ave., Port Huron, Mich.
Advance Engineering Co.....271, 272
69 Dey St., New York, N. Y.
Ahlberg Bearing Co.....427
3025 West 47th St., Chicago, Ill.
Aldrich Pump Co.....492
5 Pine St., Allentown, Pa.
Allegheny-Ludlum Steel Corp.....70
Oliver Bldg., Pittsburgh, Pa.
Allen-Bradley Co.....437–439
1326 So. 2nd St., Milwaukee, Wisc.
Allen-Sherman-Hoff Co.....60
Lewis Tower Bldg., Philadelphia, Pa.
Allis-Chalmers Mfg. Co.....3–5
Milwaukee, Wisc.
Alpha Steam Specialty Co.....248
15 Park Row, New York, N. Y.
American Artisan.....287
6 N. Michigan Ave., Chicago, Ill.
American Blower Corp.....90
6000 Russell St., Detroit, Mich.
American Brass Co.....56, 57
Waterbury, Conn.
American Car & Foundry Co.....201, 202
30 Church St., New York, N. Y.
American Gas Association.....91, 92
420 Lexington Ave., New York, N. Y.
American Metal Hose Branch of American Brass Co.....56, 57
Waterbury, Conn.
American Meter Co.....38, 39
60 E. 42nd St., New York, N. Y.
American Pulley Co.....237, 238
4200 Wissahicken Ave., Philadelphia, Pa.
American Saw Mill Machinery Co.....537
Hackettstown, N. J.
American Society of Mechanical Engineers....80
29 W. 39th St., New York, N. Y.
American Steel & Wire Co.....93, 94
Rockefeller Bldg., Cleveland, Ohio
Ames Hydrovac Corp.....77
290 Scholes St., Brooklyn, N. Y.
Ampco Metal (Inc.).....304, 305
3830 W. Burnham St., Milwaukee, Wisc.
Anderson, V. D., Co.....83
1935 W. 96th St., Cleveland, Ohio
Armstrong Machine Works.....271, 272
894 Maple St., Three Rivers, Mich.
Armstrong Steam Trap Co.....271, 272
Three Rivers, Mich.
Asbesos Distributors (Inc.).....211
Port Chester, N. Y.
Askania Regulator Co.....234
1603 S. Michigan St., Chicago, Ill.
Atlantic Gear Works.....335
128 Lafayette St., New York, N. Y.
Atlas Press Co.....404, 405
1819 N. Pitcher St., Kalamazoo, Mich.
Atlas Valve Co.....334
265 South St., Newark, N. J.
Automatic Switch Co.....550, 551
41 E. 11th St., New York, N. Y.

Badger, E. B. & Sons Co.....88
75 Pitts St., Boston, Mass.
Bailey Meter Co.....54, 55
1026 Ivanhoe Rd., Cleveland, Ohio
Baldwin Belting & Leather Co.....212
85 Chambers St., New York, N. Y.
Baldwin-Hill Co.....224
575 Klagg Ave., Trenton, N. J.
Barco Manufacturing Co.....302
1811 Winnemac Ave., Chicago, Ill.
Barrett-Cravens Co.....73
3278 W. 30th St., Chicago, Ill.
Beaver Pipe Tools.....250, 251
310 Amersome Ave., Warren, Ohio
Benjamin Electric Mfg. Co.....256, 257
Des Plaines, Ill.
Black & Decker Mfg. Co.....533, 534
Towson, Md.
Black, Sivalls & Bryson (Inc.).....532
Oklahoma City, Okla.
Bond, Charles, Co.....221, 222
617–23 Arch St., Philadelphia, Pa.
Boston Gear Works.....326–331
North Quincy, Mass.
Bradley Washfountain Co.....435, 436
N. 22 & Michigan St., Milwaukee, Wisc.
Bridgeport Brass Co.....13
Bridgeport, Conn.
Bristol Co.....81, 82
21 Bridge St., Waterbury, Conn.
Brooklyn Union Gas Co.....91, 92
176 Remsen St., Brooklyn, N. Y.

FIRST FLOOR



BOOTHS NOS. 1-95

Booth

Brown Instrument Co.....45
4496 Wayne Ave., Philadelphia, Pa.
Bruning, Charles, Co.....230, 231
100 Reade St., New York, N. Y.
Buell Engineering Co.....72
70 Pine St., New York, N. Y.
Builders Iron Foundry.....28W
25 Codding St., Providence, R. I.
Burke Electric Co.....216
Erie, Pa.

Cambridge Instrument Co.....338, 339
3732 Grand Central Term., New York, N. Y.
Carborundum Co.....22
Perth Amboy, N. J.
Carey, Philip, Co.....211
Lockland, Cincinnati, Ohio
Carnegie-Illinois Steel Corp.....93, 94
Carnegie Bldg., Pittsburgh, Pa.
Cash, A. W., Co.....340, 341
16th & Eldorado St., Decatur, Ill.
Chapman Valve Manufacturing Co.....46, 47
Indian Orchard, Mass.
Chase Brass & Copper Co.....50
236 Grand St., Waterbury, Conn.
Chicago Die Casting Mfg. Co.....426
2512 W. Monroe St., Chicago, Ill.
Chicago Metal Hose Corp.....323, 324
1305 S. 3rd St., Maywood, Ill.
Clements Manufacturing Co.....563
6650 E. Narragansett Ave., Chicago, Ill.
Cleveland Worm & Gear Co.....19
3263 E. 80th St., Cleveland, Ohio
Cling-Surface Co.....424
1032–1048 Niagara St., Buffalo, N. Y.
Clipper Belt Lacer Co.....265
974 Front Ave., N. W., Grand Rapids, Mich.
Coffin, J. S., Jr., Co.....79
Englewood, N. J.
Coffing Hoist Co.....564
Danville, Ill.
Conover-Mast Corp.....291
205 E. 42nd St., New York, N. Y.
Consolidated Edison Co. of N. Y.....91, 92
4 Irving Pl., New York, N. Y.
Continental Machines (Inc.).....545, 546
1301 Washington Ave., S., Minneapolis, Minn.
Cramer, R. W., Co.....528
Centerbrook, Conn.

Booth

Crane Co.....53
836 S. Michigan Ave., Chicago, Ill.
Crawford Engineering Co.....83
295 Madison Ave., New York, N. Y.
Crosby Steam Gage & Valve Co.....11
10 Rowland St., Boston, Mass.
Cutler-Hammer (Inc.).....321, 322
315 N. 12th St., Milwaukee, Wisc.
Cyclone Fence Co.....93, 94
Waukegan, Ill.

Dampney Co. of America.....62
1243 River St., Hyde Park, Boston, Mass.
Daniel Orifice Fittings Co.....260
Los Angeles, Calif.
Darling Valve & Manufacturing Co.....43
Williamsport, Pa.
Dayton Rubber Manufacturing Co.....312, 313
Dayton, Ohio
Delta Manufacturing Co.....502–504
600 E. Vienna Ave., Milwaukee, Wisc.
Detex Watchclock Corp.....440
86 Varick St., New York, N. Y.
Dick, R. & J., Co.....424
Colfax Ave., Passaic, N. J.
Diesel Engine Division, General Motors Sales Corp.....8
2160 W. 106th St., Cleveland, Ohio
Dietzgen, Eugene, Co.....281, 282
2425 Sheffield Ave., Chicago, Ill.
Dixon, Joseph, Crucible Co.....223
Jersey City, N. J.
duPont, E. I., deNemours & Co.....276
Wilmington, Del.
Durametallic Corp.....303
2104 Factory St., Kalamazoo, Mich.
Duro Metal Products Co.....483, 484
2649 N. Kildare Ave., Chicago, Ill.

Eagle-Picher Sales Co.....258, 259
Temple Bar Bldg., Cincinnati, Ohio
Eastern Steam Specialty Co.....242, 243, 283
125 Barclay St., New York, N. Y.
Edison, Thomas A. (Inc.).....252
Lakeside Ave., West Orange, N. J.
Edward Valve & Mfg. Co.....27
East Chicago, Ind.

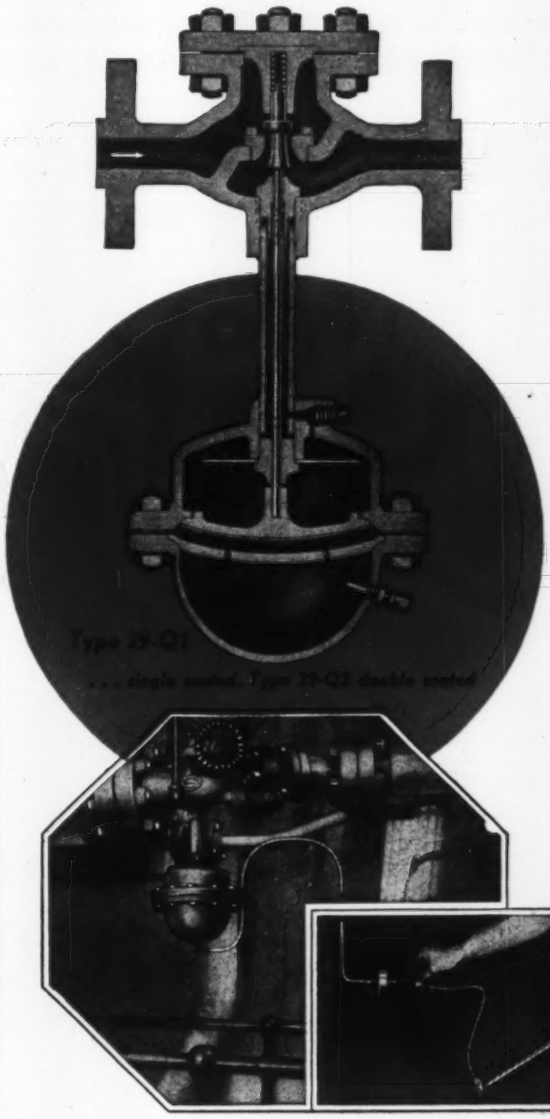
Continued on page 20

Classified List of Exhibitors' Products begins on page 25

not only new . . . but **"NEWS"!**

this **FOSTER PRESSURE REGULATOR** *combines*

ruggedness with extreme accuracy of regulation in a simple valve that has no springs, no weights to adjust or change



A typical installation of a Foster Type 39-Q1 Pressure Reducing Regulator where the dome is loaded from a distant location using a hand pump. A compressed gas bottle is used for highest pressures, and where a general air supply is available a simple distant and conveniently located pilot control valve can be employed.

Here is one of the latest developments in pressure reducing regulators . . . an air dome-loaded design for the accurate regulation of high and low pressure control of hot fluids, whether steam, liquids, or gases.

Built for initial pressures up to 2500 pounds per square inch and temperatures up to 1000 degrees Fahrenheit, this valve will handle pressure reductions of a magnitude previously impractical in a single stage. It can be adjusted for reduced pressures from 5 pounds up to within a few pounds of the initial pressure simply by changing the dome load.

There are no operating springs or weights in this simple regulator, and no stuffing box. A constant loading is imposed by air—accuracy of regulation is unaffected by spring deflection and hysteresis. The pilot design commonly used to overcome these inaccuracies is not necessary in this simple construction which is as positive as direct weight loading, but without the cumbersomeness and impracticality common to weights.

Send for this Bulletin!

This eight-page, fully-illustrated bulletin containing practical and useful information (application, features, operation, installation—also dimensions and weights) on the Foster Type 39-Q1 and 39-Q2 Pressure Reducing Regulator is just off the press. A copy will be sent to you without obligation or cost . . . simply ask for Catalog 70, Bulletin 10.

FOSTER ENGINEERING *Company*

PRESSURE REGULATORS • RELIEF AND BACK PRESSURE VALVES • AUTOMATIC STOP AND CHECK VALVES • ALTITUDE VALVES • DAMPER REGULATORS • FAN ENGINE REGULATORS PUMP GOVERNORS • TEMPERATURE REGULATORS • LIQUID LEVEL CONTROLLERS • FLOAT AND LEVER BALANCED VALVES • NON-RETURN AND TRIPLE DUTY VALVES • VACUUM REGULATORS OR BREAKERS • SIGHT FLOW BOXES • STRAINERS • SAFETY VALVES

107 MONROE ST., NEWARK, N. J.

Exhibiting at Booth 84 — New York Power Show

Fourteenth National Exposition of Power and Mechanical Engineering

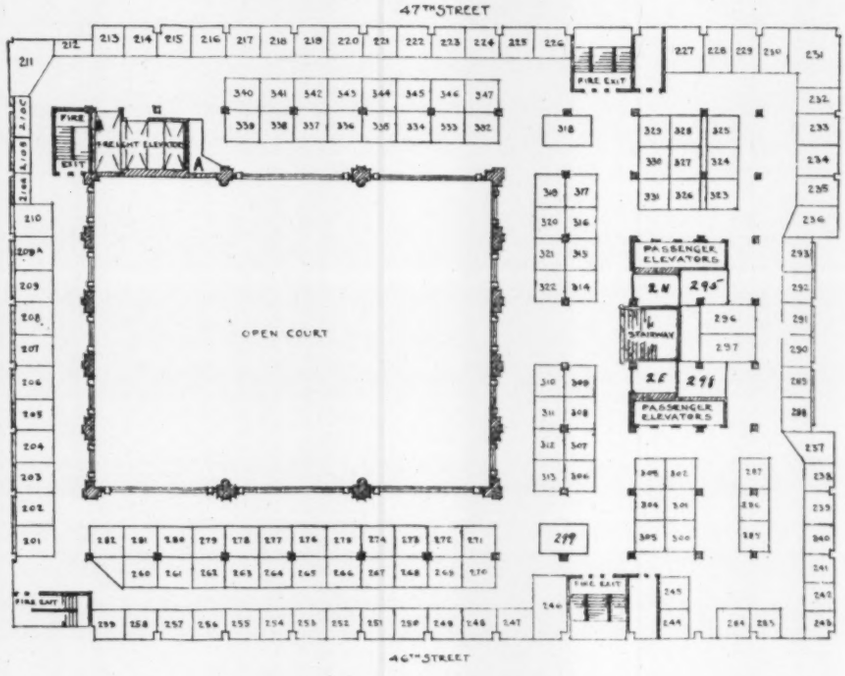
LIST *of* EXHIBITORS *and* FLOOR DIAGRAMS

Main Floor: Booths 1 to 95 **Second Floor: Booths 200 to 348** **Third Floor: Booths 401 to 569**

(Corrected to October 22, 1940 from list supplied by International Exposition Co.)

	Booth
Elastic Stop Nut Corp. 1001 Newark Ave., Newark, N. J.	241
Electric Arc Cutting & Welding Co. 152–162 Jelliff Ave., Newark, N. J.	505
Electrical World 330 W. 42nd St., New York, N. Y.	"A" Main Floor
Equipment Engineering Co. Minneapolis, Minn.	426
Everlasting Valve Co. 49–65 Fisk St., Jersey City, N. J.	41
Fairbanks Co. 393–399 Lafayette St., New York, N. Y.	78
Falstrom Co. Passaic, N. J.	543, 544
Farval Corp. Cleveland, Ohio	19
Feedrail Corp. 125 Barclay St., New York, N. Y.	558
Fink, Dumont, White (Inc.) 220 Lafayette St., New York, N. Y.	531
Fisher Governor Co. 2001 Fisher Bldg., Marshalltown, Iowa	261, 262
Foley Manufacturing Co. Minneapolis, Minn.	299
Foote Bros. Gear & Machine Corp. 5298 S. Western Blvd., Chicago, Ill.	205
Foster Engineering Co. 107 Monroe St., Newark, N. J.	84
Foxboro Co. 98 Neponset Ave., Foxboro, Mass.	14
Gale Engineering Co. 136 Liberty St., New York, N. Y.	340, 341
Garlock Packing Co. Palmyra, N. Y.	306, 307
Gates Rubber Co. Sales Division 990 S. Broadway, Denver, Colo.	263, 264
General Aniline & Film Corp., Ozalid Products Div. Anaco Road, Johnson City, N. Y.	244, 245, 284
General Motors Sales Corp., Diesel Engine Division 2160 W. 106th St., Cleveland, Ohio	8
Gilmer, L. H., Co. Tacony, Philadelphia, Pa.	214
Gordon, James T., Co. Woolworth Bldg., New York, N. Y.	19
Graton & Knight Co. Worcester, Mass.	239, 240
Grinnell Co. (Inc.) Providence, R. I.	67
Hamilton Manufacturing Co. Two Rivers, Wisc.	219, 220
Hardie Made-Rite Plug Co. 1742 2nd Ave., New York, N. Y.	345
Harris, Arthur & Co. 212 N. Aberdeen St., Chicago, Ill.	547
Hartzell Propeller Fan Co. Piqua, Ohio	507
Heating, Piping & Air Conditioning 6 N. Michigan Ave., Chicago, Ill.	287
Heating & Ventilating 148 Lafayette St., New York, N. Y.	429, 430
Hills-McCanna Co. 2349 Nelson St., Chicago, Ill.	254
Homestead Valve Mfg. Co. P. O. Box 82, Coraopolis, Pa.	242, 243, 283
Hydraulic Coupling Div., Amer. Blower Corp. 40 E. 40th St., New York, N. Y.	90
Ideal Commutator Dresser Co. 1091 Park Ave., Sycamore, Ill.	414
Independent Pneumatic Tool Co. 600 W. Jackson Blvd., Chicago, Ill.	412, 413
Industrial Power St. Joseph, Mich.	266
Industrial Press 148 Lafayette St., New York, N. Y.	429, 430
Insto-Gas Corp. 1900 E. Jefferson Ave., Detroit, Mich.	540
International Nickel Co. 67 Wall St., New York, N. Y.	9
International Resistance Co. 401 N. Broad St., Philadelphia, Pa.	210A
Janette Mfg. Co. 556 W. Monroe St., Chicago, Ill.	213
Janney Cylinder Co. 7425 State Rd., Philadelphia, Pa.	324, 325
Jenkins Bros. 80 White St., New York, N. Y.	74, 75
Jerguson Gage & Valve Co. Mystic Ave. & Fillaway, Somerville, Mass.	260
Johns Conveyor Division, Osborn Mfg. Co. 5401 Hamilton Ave., Cleveland, Ohio	51

SECOND FLOOR



BOOTHS NOS. 200-348

	Booth
Johns-Manville 22 E. 40th St., New York, N. Y.	20
Johnson Corp. Three Rivers, Mich.	273, 274
Kaye & MacDonald (Inc.) 94 Franklin Ave., West Orange, N. J.	253
Keasbey & Mattison Co. Ambler, Pa.	2
Keasbey, Robert A. Co. 141 W. 19th St., New York, N. Y.	211
Keeney Publishing Co. 6 N. Michigan Ave., Chicago, Ill.	287
Kent Co. (Inc.) Rome, N. Y.	549
Keuffel & Esser Co. 127 Fulton St., New York, N. Y.	206–208
Kron Co. Bridgeport, Conn.	316, 317
LaFavorite Rubber Mfg. Co. P. O. Box 1468, Paterson, N. J.	318
Lebanon Steel Foundry Lebanon, Pa.	346, 347
Leeds & Northrup Co. 4963 Stenton Ave., Philadelphia, Pa.	18
Lever, George C., Co. 50 Church St., New York, N. Y.	432
Link-Belt Co. 300 W. Pershing Rd., Chicago, Ill.	288–290
Lonergan, J. E., Co. 211–217 Race St., Philadelphia, Pa.	242, 243, 283
Lunkenheimer Co. P. O. Box 360 Annex Sta., Cincinnati, Ohio	52
Lyon Iron Works Greene, N. Y.	548
McAlear Mfg. Co. 1901 S. Western Ave., Chicago, Ill.	242, 243, 283
McGraw-Hill Publishing Co. 330 W. 42nd St., New York, N. Y.	42
Machinery—Industrial Press 148 Lafayette St., New York, N. Y.	429, 430
Marlo Co. 60 Grand St., New York, N. Y.	530
Mechanical Engineering 29 W. 39th St., New York, N. Y.	80
Melrath Supply & Gasket Co. Tioga & Memphis Sts., Philadelphia, Pa.	255
Mercoid Corp. 4201 Belmont Ave., Chicago, Ill.	85, 86
Mercury Manufacturing Co. 4160 S. Halstead St., Chicago, Ill.	552, 553
Mill & Factory 205 E. 42nd St., New York, N. Y.	291
Minneapolis-Honeywell Regulator Co. 4496 Wayne Ave., Philadelphia, Pa.	48
Modine Manufacturing Co. Racine, Wisc.	336, 337
Moore, J. Arthur 342 Madison Avenue, New York, N. Y.	260
Morse Chain Co. Ithaca, N. Y.	267, 268
Morse Magneto Clock Co. 17 E. 42nd St., New York, N. Y.	210C
Nash Engineering Co. 224 Wilson Rd., South Norwalk, Conn.	16
Nathan Manufacturing Co. 250 Park Ave., New York, N. Y.	292, 293
National Aluminate Corp. 6219 W. 68th Pl., Chicago, Ill.	203, 204
National Engineer 176 W. Adams St., Chicago, Ill.	11A
National Lock Washer Co. 40 Hermon St., Newark, N. J.	344
National Tube Co. 1802 Frick Bldg., Pittsburgh, Pa.	93, 94
New Jersey Machine Corp. Hoboken, N. J.	434
Nicholson File Co. 23 Acorn St., Providence, R. I.	489
Norma-Hoffmann Bearings Corp. Stamford, Conn.	277, 278
Nugent, Wm. W. & Co. 407 N. Hermitage St., Chicago, Ill.	232, 233
Nutting Truck Co. Faribault, Minn.	431
Ohio Gear Co. 1333 E. 179th St., Cleveland, Ohio	428
Olsen, Tinius, Testing Machine Co. 500 N. 12th St., Philadelphia, Pa.	17

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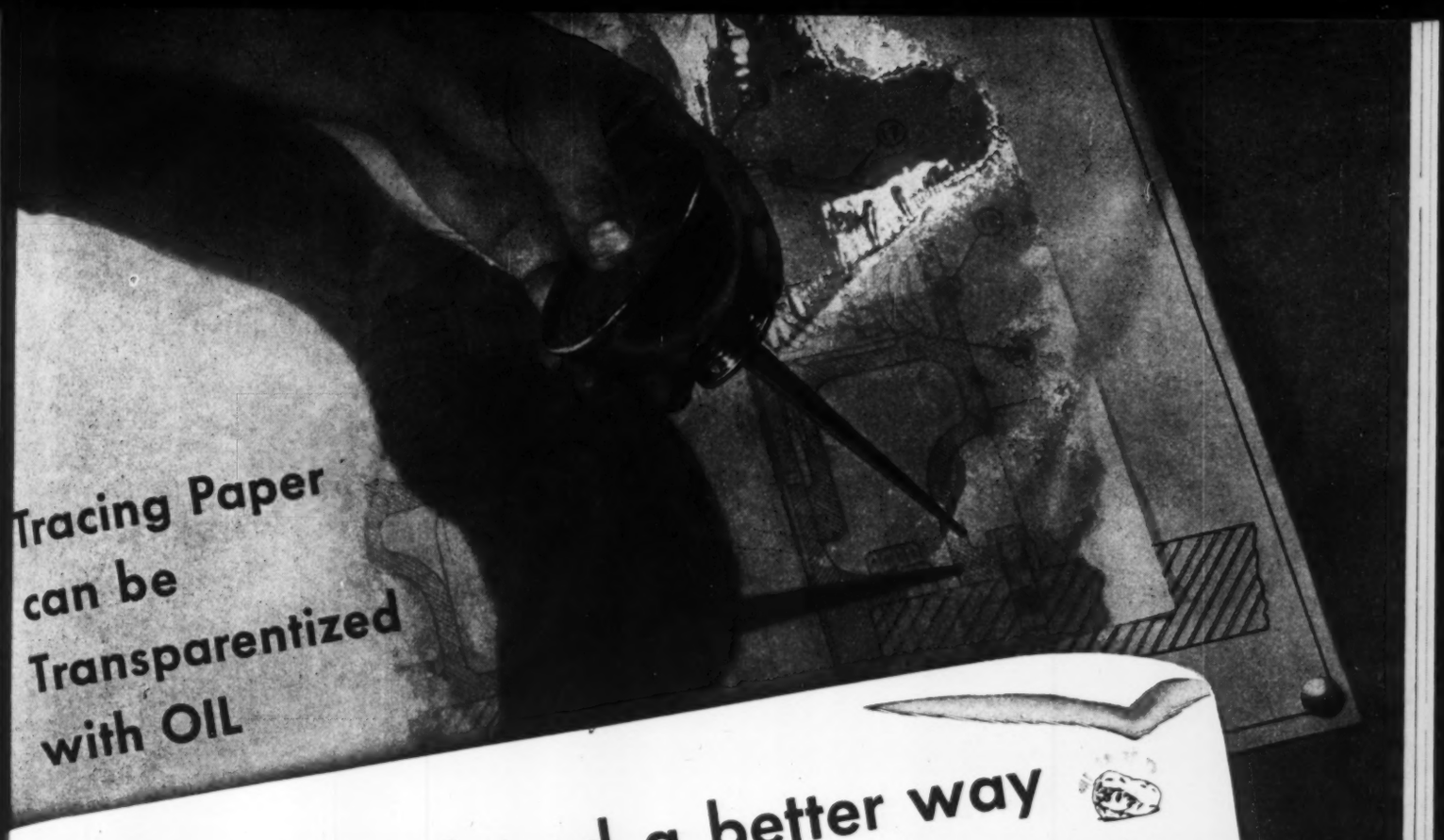
Classified List of Exhibitors' Products begins on page 25



but we have found a better way

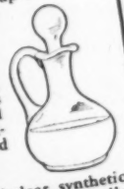
radically new transparentizing ent—developed in the K&E labor- tories—produced this truly perma- ent tracing paper! Albanene is made of 100% long fiber pure white rags treated with *Albanite*, a new crystal clear synthetic solid. It is free from oil and wax—physically and chemically inert. Albanene will not oxidize, turn yellow, become brittle or lose transparency with age.

Equally important, Albanene has *all* the working qualities you've always wanted . . . a fine hard "tooth" that takes ink or pencil beautifully and erases with ease . . . a high degree of transparency that makes tracing simple and produces strong sharp blueprints . . . and extra strength to stand up under constant corrections, filing and rough handling. Because Albanene is truly permanent, *it will retain all these characteristics indefinitely!*

Try Albanene yourself, on your own drawing board. Ask your K&E dealer, or write us, for an illustrated brochure and a generous working sample.

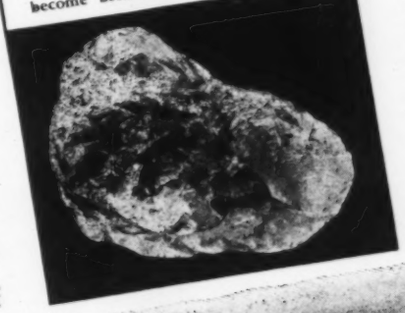
Most tracing papers are treated with OIL

MINERAL OIL. Most tracing papers are treated with some kind of oil. Mineral oil is physically unstable, tends to "drift," never dries completely. Papers treated with mineral oil pick up dust, lose transparency with age.



VEGETABLE OIL, chemically unstable, oxidizes easily. Papers treated with vegetable oil become rancid and brittle, turn yellow and opaque with age.

ALBANITE is a crystal-clear synthetic solid, free from oil and wax, physically and chemically inert. Because of this new stabilized transparentizing agent, Albanene is unaffected by harsh climates—will not oxidize, turn yellow, become brittle or lose transparency.



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THE STABILIZED TRACING PAPER

Fourteenth National Exposition of Power and Mechanical Engineering

LIST *of* EXHIBITORS *and* FLOOR DIAGRAMS

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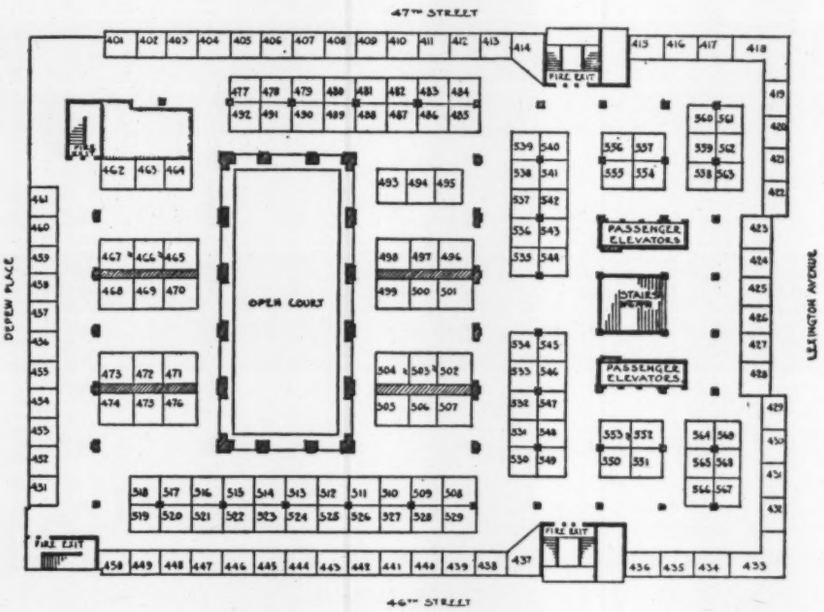
THIRD FLOOR



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Classified List of Exhibitors' Products begins on page 25

This Check List will help you buy PERMANENT insulating effectiveness

FOR any insulating material to provide maximum fuel or refrigeration savings . . . *and keep on providing them, year in, year out* . . . it must stand up under careful checking with the list at the right. If the materials you are now using do not meet these requirements, you can select a Johns-Manville Insulation that does.

LOW CONDUCTIVITY	This, of course, is the first thing you look for in insulation. Because Johns-Manville Insulations provide lowest conductivity consistent with strength and other essentials, they assure initial high fuel savings that continue throughout years of service.	✓
TEMPERATURE RESISTANCE	To maintain its original effectiveness, the insulation you use must remain unaffected by the temperatures to which it is subjected. From the complete line of J-M Insulations, you can select the right material for any temperature from 400° F. below to 2500° F. above.	✓
CRUSHING STRENGTH	In locations where it is subjected to compressive loads, the insulation must be able to maintain its strength and true form, even while heated to service temperatures. For such services, the J-M line offers insulating materials with unusually high load-bearing capacities.	✓
BREAKING STRENGTH	Resistance to breaking is important in guarding against damage during transportation and installation. Certain services also demand more than ordinary toughness in insulations. Many J-M materials have unusually high resistance to breaking, as measured by transverse strength.	✓
FULL THICKNESS	For maximum insulating protection, the insulation you use must not sag or compress during application, or deteriorate in service. J-M Block and Pipe Insulations are designed to avoid such dangers . . . and they can be applied without risk of voids or thin spots.	✓
MOISTURE RESISTANCE	This feature is particularly important in refrigeration service, since moisture infiltration causes most low-temperature insulation failures. J-M Refrigeration Insulations offer unusual moisture resistance, and, because of their basically mineral composition, are rotproof and verminproof as well.	✓
STABILITY IN SERVICE	If maximum fuel or refrigeration savings are to continue indefinitely, the insulation you use must not only possess the above characteristics at the start, it must retain them throughout the life of the equipment on which it is used. The column at the left gives some brief facts on a few of the many J-M Insulating Materials.	

Check the Characteristics of these J-M Insulating Materials

H-T SUPEREX BLOCKS. For many years the most widely used block insulation for temperatures to 1900° F. Combines high heat resistance and low thermal conductivity. Furnished 3" to 12" wide; 18" and 36" long; from 1" to 4" thick.

L-W SUPEREX BLOCKS AND PIPE INSULATION. New-type Superex Block and Pipe Insulation for temperatures to 1500° F. Light in weight, high in insulating efficiency, unusually resistant to compression and breaking. Pipe Insulation in all sizes. Blocks same sizes as H-T Superex.

ASBESTO-SPONGE FELTED SHEETS AND PIPE INSULATION. For temperatures to 700° F. where maximum efficiency, salvage value and resistance to vibration and abuse are essential. For outdoor lines, pipe insulation furnished with waterproof jacket. Sheets 6" to 36" wide; 36" long; ½" to 4" thick. Pipe Insulation in all standard sizes.

J-M 85% MAGNESIA BLOCKS AND PIPE INSULATION. Long recognized as the standard material for temperatures to 600° F. Maintains its high insulating efficiency through years of service. Blocks 3" to 12" wide; 18" or 36" long; 1" to 4" thick. Pipe Insulation in all standard sizes.

J-M ROCK CORK SHEETS AND PIPE INSULATION. For cold-storage rooms, refrigerated equipment and piping. Basically mineral, it can't rot, won't harbor vermin or support mold. Highly moisture-resistant, stays permanently efficient in service. Sheets 18" wide; 36" long; 1½" to 4" thick. Also furnished as lagging and pipe insulation.

SIL-O-CEL C-22 BRICK. Insulating refractory for temperatures up to 2000° F. Heat-storage capacity less than ⅓ that of firebrick; is 3 to 4 times more effective in preventing transmitted heat loss. Crushing strength—700 lbs./sq. in. Standard firebrick sizes and shapes.

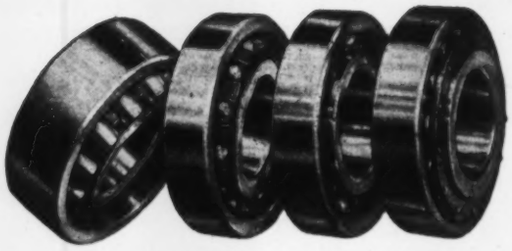
JM-20 BRICK. New-type insulating-refractory brick for temperatures up to 2000° F. Unusually light in weight (1.9 lbs. per standard 9" equivalent). Standard firebrick sizes and shapes.

FOR DETAILS on the complete line of J-M Insulating Materials, write for Catalog IN-55A. Johns-Manville, 22 East 40th St., New York, N. Y.

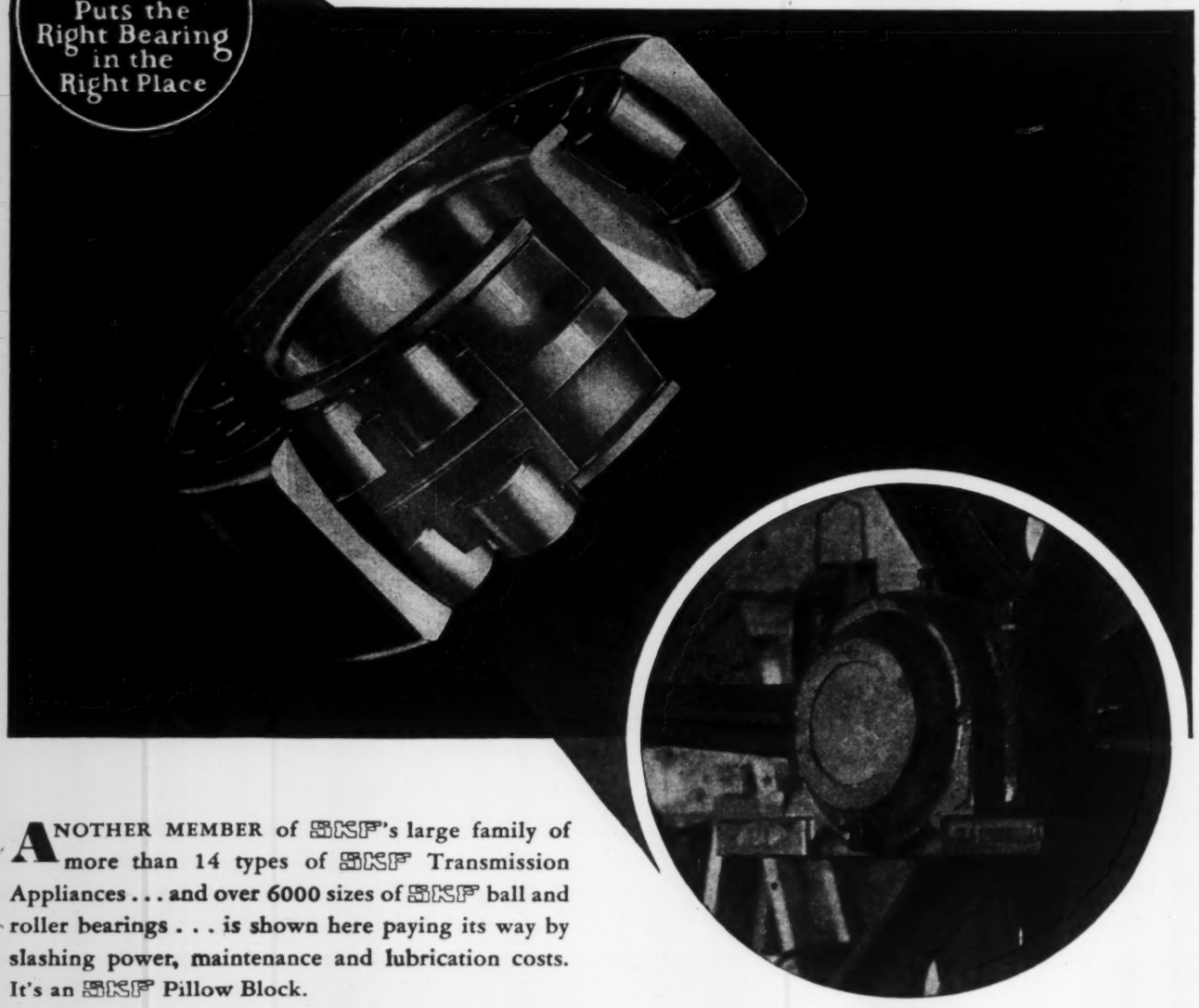
Johns-Manville INDUSTRIAL INSULATIONS

For every temperature . . . for every service

IF IT'S AN SKF PILLOW BLOCK, YOU SLASH OPERATING COSTS OF ALL KINDS



SKF
Puts the Right Bearing in the Right Place



ANOTHER MEMBER of SKF's large family of more than 14 types of SKF Transmission Appliances . . . and over 6000 sizes of SKF ball and roller bearings . . . is shown here paying its way by slashing power, maintenance and lubrication costs. It's an SKF Pillow Block.

It's easy to assemble, inspect, and lubricate. It keeps lubricant from leaking, and dust and moisture from entering the bearing. It's an SKF-engineered unit. If you need a pillow block assembly for any shaft of from 5/8" in diameter up, consult your local SKF distributor TODAY. 4475

SKF INDUSTRIES, INC., PHILADELPHIA, PA.

See Our Exhibit in Booths 232-33 at the Power Show

SKF
BALL & ROLLER BEARINGS

CLASSIFIED LIST *of* EXHIBITORS' PRODUCTS

See pages 18, 20 and 22 for Alphabetical List of Exhibitors and Floor Diagrams

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Sullivan Machinery Co.
Air Conditioning Equipment
American Blower Corp.
Falstrom Co.
Grinnell Co.
Air Control Devices
Schrader's Div., Scovill Mfg. Co.
Alarms, Fire
Morse Magneto Clock Co.
Schade Valve Mfg. Co.
Alloys, Non-Ferrous
American Brass Co.
Phelps Dodge Copper Prod. Corp.
Scovill Mfg. Co.
Arbors
Chicago Die Casting Mfg. Co.
Arches, Furnace
Carborundum Co.
Plibrico Jointless Firebrick Co.
Reintjes, George P., Co.
Asbestos
Carey, Philip, Co.
Johns-Manville
Ash Handling Systems
Allen-Sherman-Hoff Co.
Autoclaves
Badger, E. B. & Sons Co.
Axels, Car and Locomotive
American Car & Foundry Co.

Babbitt Metal
Ryerson, Joseph T. & Son
Baffles
Plibrico Jointless Firebrick Co.
Smith, Sanford C., Refractories
Balancing Machines
Olsen, Tinius, Testing Mach. Co.
Balls, Brass, Bronze, and Steel
S K F Industries (Inc.)
Bars, Brass and Copper
American Brass Co.
Revere Copper & Brass (Inc.)
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Bars, Steel
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Carnegie-Illinois Steel Corp.
Republic Steel Corp.
Ryerson, Joseph T. & Son
United States Steel Corp.
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Cyclone Fence Co.
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Edison, Thomas A. (Inc.)
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Norma-Hoffmann Bearings Corp.
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Norma-Hoffmann Bearings Corp.
S K F Industries (Inc.)
Bearings, Radial
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Norma-Hoffmann Bearings Corp.
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Ahlberg Bearing Co.
Bond, Charles, Co.
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Norma-Hoffmann Bearings Corp.
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Wood's, T. B., Sons Co.
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Link-Belt Co.
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S K F Industries (Inc.)
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Belting, Conveyor
Dick, R. & J., Co.
Link-Belt Co.
Belting, Elevator
Dick, R. & J., Co.
Belting, Endless
Baldwin Belting & Leather Co.
Gates Rubber Co. Sales Div.
Gilmer, L. H., Co.
Belting, Fabric
Gates Rubber Co. Sales Div.
Gilmer, L. H., Co.
Belting, Leather
Baldwin Belting & Leather Co.
Bond, Charles, Co.
Graton & Knight Co.
Rhoads, J. E. & Sons
Belting, Round
Baldwin Belting & Leather Co.
Gates Rubber Co. Sales Div.
Rhoads, J. E. & Sons
Belting, Rubber
Garlock Packing Co.
Gates Rubber Co. Sales Div.
Gilmer, L. H., Co.
Belting, "V" Leather, Rubber, etc.
Baldwin Belting & Leather Co.
Bond, Charles, Co.
Dick, R. & J., Co.
Gates Rubber Co. Sales Div.
Gilmer, L. H., Co.
Belts, Chain
Link-Belt Co.
Morse Chain Co.
Belts, Conveyor, Metal
Cyclone Fence Co.
Benchboard Control Sections
Falstrom Co.
Bending and Coiling Machines, Tube
Parker Appliance Co.
Bending Machines, Hand
Parker Appliance Co.
Bending Machines, Pipe, Tubing, etc.
Parker Appliance Co.
Bending Machines, Sheet Metal
Whitney Metal Tool Co.
Beryllium-Copper
American Brass Co.
Bins, Elevated, Steel
Richardson Scale Co.
Blades, Hack Saw
Thompson, Henry G. & Son Co.
Blocks, Furnace, Arch and Wall
Carborundum Co.
Smith, Sanford C., Refractories
Blocks, Insulating, Heat
Eagle-Picher Sales Co.
Johns-Manville
Quigley Co.
Refractory & Insulation Corp.
Blocks, Pillow
Ahlberg Bearing Co.
Bond, Charles, Co.
Chicago Die Casting Mfg. Co.
Dick, R. & J., Co.
Link-Belt Co.
Norma-Hoffmann Bearings Corp.
S K F Industries (Inc.)
Blowdown Systems, Boiler
Permutit Co.
Blowers, Centrifugal
Allis-Chalmers Mfg. Co.
American Blower Corp.
Spencer Turbine Co.
Wing, L. J., Mfg. Co.
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Hartzell Propeller Fan Co.
New Jersey Machine Corp.
Prat-Daniel Corp.
Wing, L. J., Mfg. Co.
Blowers, Portable, Electric
Clements Mfg. Co.
Ideal Commutator Dresser Co.
Blowers, Pressure
Allis-Chalmers Mfg. Co.
American Blower Corp.
Spencer Turbine Co.
Blowers, Rotary
Nash Engineering Co.
Spencer Turbine Co.
Blowers, Soot
Spencer Turbine Co.
Blowers, Turbine
Spencer Turbine Co.
Wing, L. J., Mfg. Co.
Boards, Gage
Bailey Meter Co.
Bristol Co.
Foxboro Co.
Lonergan, J. E., Co.
Republic Flow Meters Co.
Taylor Instrument Companies
Boilers, Fire-Tube
Vogt, Henry, Machine Co.
Boilers, Water Tube, Inclined
Vogt, Henry, Machine Co.
Boosters, Gas
American Blower Corp.
Boxes, Annealing and Carburizing
American Car & Foundry Co.
S K F Industries (Inc.)
Boxes, Journal
American Pulley Co.
Bond, Charles, Co.
Link-Belt Co.
S K F Industries (Inc.)
Boxes, Resistance, Electrical
National Lock Washer Co.
Brass, Roll, Sheet, etc.
American Brass Co.
Bridgeport Brass Co.
Chase Brass & Copper Co.
Scovill Mfg. Co.
Breakers, Circuit
Cutler-Hammer (Inc.)
Russell & Stoll Co.
Breechings, Smoke
Falstrom Co.
Brick, Fire Clay
Plibrico Jointless Firebrick Co.
Quigley Co.
Remmey, Richard C., Son Co.
Smith, Sanford C., Refractories
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Quigley Co.
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Quigley Co.
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Bridgeport Brass Co.
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Dixon, Jos., Crucible Co.
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Link-Belt Co.
Buckets, Dragline
Sauerman Bros.
Buckets, Skip-Hoist
Link-Belt Co.
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Black & Decker Mfg. Co.
Bunkers, Coal and Ash
Allen-Sherman-Hoff Co.
Burners, Gas and Oil
Zink, John, Burner Co.
Bushings, Condenser, Tube, Inlet End
Scovill Mfg. Co.
Bus-Way Systems, Electric
Feedrail Corp.
Lebanon Steel Foundry

Cabinets, Blueprint Filing
Hamilton Manufacturing Co.
Keuffel & Esser Co.
Post, Frederick, Co.
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American Car & Foundry Co.
Casters, Truck
Fairbanks Co.
Lever, George C., Co.
Nutting Truck Co.
Service Caster & Truck Co.
Castings, Acid Resistant
Allegheny-Ludlum Steel Corp.
Ampco Metal (Inc.)
Castings, Alloy, Die Cast
Chicago Die Casting Mfg. Co.
Castings, Alloy Steel
Lebanon Steel Foundry
Castings, Aluminum
Aldrich Pump Co.
Parker Appliance Co.
Scovill Mfg. Co.
Castings, Brass
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Chase Brass & Copper Co.
Grinnell Co.
Hills-McCanna Co.
Homestead Valve Mfg. Co.
Nathan Manufacturing Co.
Parker Appliance Co.
Scovill Mfg. Co.
Castings, Brass, Die Cast
American Brass Co.
Castings, Bronze
Aldrich Pump Co.
Ampco Metal (Inc.)
Grinnell Co.
Hills-McCanna Co.
Homestead Valve Mfg. Co.
Nathan Manufacturing Co.
Parker Appliance Co.
Scovill Mfg. Co.
Castings, Centrifugal
Janney Cylinder Co.
Castings, Chrome-Nickel-Steel
Lebanon Steel Foundry
Castings, Iron
Aldrich Pump Co.
Allegheny-Ludlum Steel Corp.
American Car & Foundry Co.
Grinnell Co.
Homestead Valve Mfg. Co.
Wood's, T. B., Sons Co.
Castings, Nickel-Copper
International Nickel Co.
Castings, Semi-Steel
Aldrich Pump Co.
Homestead Valve Mfg. Co.
Castings, Steel
Allegheny-Ludlum Steel Corp.
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Lebanon Steel Foundry
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Carey, Philip, Co.
Johns-Manville
Plibrico Jointless Firebrick Co.
Cement, Belt
Bond, Charles, Co.
Graton & Knight Co.
Cement, Insulating, Heat
Baldwin-Hill Co.
Eagle-Picher Sales Co.
Johns-Manville
Plibrico Jointless Firebrick Co.
Quigley Co.
Smith, Sanford C., Refractories
Cement, Iron, Steel, Non-Ferrous, etc.
Robinson, John R.
Cement, Pipe Joint
Grinnell Co.
Cement, Refractory
Carborundum Co.
Carey, Philip, Co.
Johns-Manville
Plibrico Jointless Firebrick Co.
Quigley Co.
Refractory & Insulation Corp.
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Link-Belt Co.
Morse Chain Co.
Chains and Sprockets
Boston Gear Works
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Reading-Pratt & Cady Co.
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Ward Leonard Electric Co.
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Vogt, Henry, Machine Co.
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Williams, J. H. & Co.
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Cleaners, Tube, Boiler
Pittsburgh Pipe Cleaner Co.
Robinson, John R.
Spencer Turbine Co.
Cleaning Machines, Vacuum
Clements Mfg. Co.
Spencer Turbine Co.
Clips, Metal, Self-Locking
Tinnerman Products (Inc.)
Clocks, Gage Board
Bristol Co.
Brown Instrument Co.
Lonergan, J. E., Co.
Clocks, Time Recording
Morse Magneto Clock Co.
Clocks, Watchman's Recording
Detex Watchclock Corp.
Cloth, Blueprint, Brownprint, etc.
Bruning, Charles, Co.
Dietzgen, Eugene, Co.
Post, Frederick, Co.
Cloth, Tracing
Bruning, Charles, Co.
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Post, Frederick, Co.
Cloth, Wire
Cyclone Fence Co.
Clutches, Friction
Foote Bros. Gear & Mach. Corp.
Link-Belt Co.
Morse Chain Co.
Wood's, T. B., Sons Co.
Clutches, Jaw
Foote Bros. Gear & Mach. Corp.
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Clutches, Magnetic
Cutler-Hammer (Inc.)
Coagulants, Water Treatment
National Aluminate Corp.
Coatings, Boiler Setting
Carey, Philip, Co.
Johns-Manville
Plibrico Jointless Firebrick Co.
Coatings, Metal Protecting
Dampney Co. of America
Cocks, Air
Homestead Valve Mfg. Co.
Parker Appliance Co.
Powell, Wm., Co.
Cocks, Blow-Off
Fairbanks Co.
Homestead Valve Mfg. Co.
Cocks, Four-Way
Homestead Valve Mfg. Co.
Parker Appliance Co.
Cocks, Gage
Edward Valve & Mfg. Co.
Jerguson Gage & Valve Co.
Lonergan, J. E., Co.
Lunkenheimer Co.
Nathan Manufacturing Co.
Parker Appliance Co.
Powell, Wm., Co.
Wright-Austin Co.
Cocks, Three-Way
Homestead Valve Mfg. Co.
Lonergan, J. E., Co.
Parker Appliance Co.
Cocks, Two-Way
Homestead Valve Mfg. Co.
Parker Appliance Co.
Coils, Pipe, Tubing, etc.
American Blower Corp.
Grinnell Co.
Harris, Arthur & Co.
Modine Mfg. Co.
Parker Appliance Co.
Vogt, Henry, Machine Co.

Continued on page 26

CLASSIFIED LIST *of* EXHIBITORS' PRODUCTS

See pages 18, 20 and 22 for Alphabetical List of Exhibitors and Floor Diagrams

Collars, Shaft
American Pulley Co.
Bond, Charles, Co.
Collecting Systems, Dust
Allen-Sherman-Hoff Co.
American Blower Corp.
Buell Engineering Co.
Falstrom Co.
Spencer Turbine Co.
Combustion Control Systems
Republic Flow Meters Co.
Wheelco Instruments Co.
Compounds, Boiler
Acheson Colloids Corp.
National Aluminate Corp.
Compounds, Case Hardening
duPont, E. I., deNemours & Co.
Compounds, Cutting
Acheson Colloids Corp.
Compounds, Grinding
Carborundum Co.
Compounds, Hardening, Steel
duPont, E. I., deNemours & Co.
Compounds, Lapping
Carborundum Co.
Compounds, Pipe Joint
Dixon, Joseph, Crucible Co.
Garlock Packing Co.
Grinnell Co.
Compressors, Air, Gas, etc.
Allis-Chalmers Mfg. Co.
Nash Engineering Co.
Schramm (Inc.)
Spencer Turbine Co.
Sullivan Machinery Co.
Wright Mfg. Div., Amer. Chain Co.
Condensation Return Systems
Anderson, V. D., Co.
Nash Engineering Co.
Condensers
Allis-Chalmers Mfg. Co.
Conduits, Underground Pipe Line
Badger, E. B. & Sons Co.
Ric-wiL Co.
Control Systems, Combustion
Askania Regulator Co.
Bailey Meter Co.
Brown Instrument Co.
Cash, A. W., Co.
Leeds & Northrup Co.
Mercoid Corp.
Minneapolis-Honeywell Reg. Co.
Photoswitch (Inc.)
Republic Flow Meters Co.
Spence Engineering Co.
Control Systems, Draft
Askania Regulator Co.
Bailey Meter Co.
Brown Instrument Co.
Cash, A. W., Co.
Leeds & Northrup Co.
Mercoid Corp.
Minneapolis-Honeywell Reg. Co.
Republic Flow Meters Co.
Control Systems, Stoker
Askania Regulator Co.
Bailey Meter Co.
Cash, A. W., Co.
Mercoid Corp.
Republic Flow Meters Co.
Controllers, Draft
Wheelco Instruments Co.
Controllers, Electric
Allen-Bradley Co.
Cutler-Hammer (Inc.)
Ward Leonard Electric Co.
Controllers, Filter Rate
Builders Iron Foundry
Cash, A. W., Co.
Controllers, Liquid Level
American Meter Co.
Askania Regulator Co.
Bailey Meter Co.
Bristol Co.
Builders Iron Foundry
Cash, A. W., Co.
Fisher Governor Co.
Foster Engineering Co.
Foxboro Co.
Lunkenheimer Co.
McAlear Mfg. Co.
Mercoid Corp.
Republic Flow Meters Co.
Schade Valve Mfg. Co.
Taylor Instrument Companies
Controllers, Temperature
Wheelco Instruments Co.
Controllers, Time
Bristol Co.
Cramer, R. W., Co.
Photoswitch (Inc.)
Taylor Instrument Companies
Controllers, Time Cycle
Bailey Meter Co.
Bristol Co.
Builders Iron Foundry
Cramer, R. W., Co.
Foxboro Co.
Leeds & Northrup Co.
Taylor Instrument Companies
Controllers, Valve, Elect. Operated
Leeds & Northrup Co.
Mercoid Corp.
Minneapolis-Honeywell Reg. Co.
Controls, Motor, Electric
Russell & Stoll
Controls, Safety, for Presses
Schrader's Div., Scovill Mfg. Co.
Conveying Machinery
Allis-Chalmers Mfg. Co.
Link-Belt Co.
Conveying Systems, Ash
Link-Belt Co.
Conveying Systems, Hydraulic
Allen-Sherman-Hoff Co.
Conveying Systems, Pneumatic
American Blower Corp.
Conveyors, Belt
Johns Conveyor Div., Osborn Mfg. Co.
Link-Belt Co.
Conveyors, Scraper, Flight
Johns Conveyor Div., Osborn Mfg. Co.
Coolers, Brine
Vogt, Henry, Machine Co.
Coolers, Oil
Vogt, Henry, Machine Co.
Coolers, Rotary
Allis-Chalmers Mfg. Co.
Coolers, Water
American Blower Corp.
Cooling Systems, Generator
American Blower Corp.
Cooling Systems, Spray
Yarnall-Waring Co.
Copying Machines, Photographic
Ozalid Products Div., General Aniline & Film Corp.
Counters, Photoelectric
Photoswitch (Inc.)
Counters, Revolution
Bristol Co.
Brown Instrument Co.
Countershafts
Bond, Charles, Co.
Wood's, T. B., Sons Co.
Couplers, Air Hose, Quick Acting
Schrader's Div., Scovill Mfg. Co.
Couplings, Hose
Packless Metal Products Corp.
Couplings, Pipe
National Tube Co.
Parker Appliance Co.
Couplings, Shaft, Cut-Off
Wood's, T. B., Sons Co.
Couplings, Shaft, Flexible
Bond, Charles, Co.
Boston Gear Works
Chicago Die Casting Mfg. Co.
Foote Bros. Gear & Mach. Corp.
Link-Belt Co.
Morse Chain Co.
Philadelphia Gear Works
Universal Gear Corp.
Wood's, T. B., Sons Co.
Couplings, Shaft, Hydraulic, Fluid Drive
American Blower Corp.
Couplings, Tubing
Packless Metal Products Corp.
Parker Appliance Co.
Coverings, Asbestos
Carey, Philip, Co.
Johns-Manville
Coverings, Boiler Setting
Johns-Manville
Keasbey & Mattison Co.
Refractory & Insulation Corp.
Coverings, Pipe and Tank
Carey, Philip, Co.
Johns-Manville
Keasbey & Mattison Co.
Refractory & Insulation Corp.
Coverings, Steam Pipe, Underground
Ric-wiL Co.
Cranes, Hand Power
Wright Mfg. Div., Amer. Chain Co.
Yale & Towne Mfg. Co.
Cranes, Jib
Wright Mfg. Div., Amer. Chain Co.
Yale & Towne Mfg. Co.
Cranes, Locomotive
Link-Belt Co.
Crucibles
Carborundum Co.
Dixon, Joseph, Crucible Co.

COMBUSTION CONTROL

All Sizes of Boilers All Types of Firing

Low steam costs are the result of high boiler efficiency. Daily performance at test efficiencies will result from the installation of a Republic-Smoot combustion control system. They are designed for all sizes of boilers and all types of fuel firing equipment.

CONSTANT STEAM PRESSURE

Automatically maintains a constant steam pressure by controlling the fuel and air input to the boilers in balance with the boiler load.

EFFICIENT COMBUSTION

Automatically maintains maximum combustion efficiency over entire range of boiler rating, by controlling simultaneously the fuel and air input to boiler in measured proportions and in a fixed ratio.

LOAD DISTRIBUTION

Automatically distributes load equally among all the boilers, or the load can be distributed between the boilers as desired.

TYPICAL INSTALLATIONS

R. C. A. MANUFACTURING CO.
PENICK & FORD, LTD. INC.
JACOB RUPPERT BREWING CO.
W. VIRGINIA PULP & PAPER CO.
BEECHNUT PACKING CO.
TIMKEN ROLLER BEARING CO.
CELANESE CORP.
SWIFT & CO.
KREY PACKING CO.
U. S. MILITARY ACADEMY
U. S. NAVAL ACADEMY
STEVENS HOTEL

FOR COMPLETE DETAILS WRITE FOR DATA BOOK No. S-21

REPUBLIC FLOW METERS CO. 2222 DIVERSEY PKWY. CHICAGO, ILLINOIS

CLASSIFIED LIST *of* EXHIBITORS' PRODUCTS

See pages 18, 20 and 22 for Alphabetical List of Exhibitors and Floor Diagrams

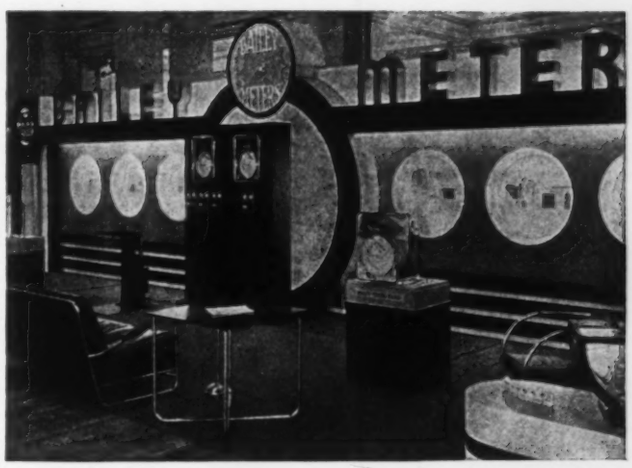
Crushers
Allis-Chalmers Mfg. Co.
Link-Belt Co.
Cups, Grease
Lonergan, J. E., Co.
Lunkenheimer Co.
Nathan Manufacturing Co.
Powell, Wm., Co.
Cups, Oil
Lonergan, J. E., Co.
Lunkenheimer Co.
Nathan Manufacturing Co.
Powell, Wm., Co.
Cutters, Pipe, Tubing, etc.
Beaver Pipe Tools
Ridge Tool Co.
Toledo Pipe Threading Mach. Co.
Trimont Mfg. Co.
Cutting Mac ines, Belt, Hand
Clipper Belt Lacer Co.
Cutting and Threading Machines, Pipe
Beaver Pipe Tools
Oster Mfg. Co.
Toledo Pipe Threading Mach Co.
Cutting-Off Machines, Metal
Delta Mfg. Co.
Cylinders, Air or Hydraulic Operated
Cash, A. W., Co.

Dehumidifiers
American Blower Corp.
Dehydrators
Buell Engineering Co.
Desuperheaters
Republic Flow Meters Co.
Spence Engineering Co.
Dies, Stamping
Continental Machines (Inc.)
Dies, Thread Cutting, Pipe
Ridge Tool Co.
Digesters
Badger, E. B. & Sons Co.
Disks, Abrasive
Carborundum Co.
Disks, Valve
Garlock Packing Co.
Jenkins Bros.
Johns-Manville
LaFavorite Rubber Mfg. Co.
Powell, Wm., Co.
Dogs, Lathe, etc.
Williams, J. H. & Co.
Doors, Boiler Furnace
Reintjes, George P., Co.
Drafting Machines
Dietzgen, Eugene, Co. (Inc.)
Keuffel & Esser Co.
Post, Frederick, Co.
Draw-Off Systems, Boiler
Everlasting Valve Co.
Dressers, Commutator
Ideal Commutator Dresser Co.
Dressers, Grinding Wheel
Carborundum Co.
Dressings, Belt
Cling-Surface Co.
Dixon, Jos., Crucible Co.
Graton & Knight Co.
Rhoads, J. E. & Sons
Driers, Blueprint, etc.
Pease, C. F., Co.
Driers, Direct Heat
Allis-Chalmers Mfg. Co.
Driers, Indirect Heat
Allis-Chalmers Mfg. Co.
Carborundum Co.
Drilling Machines
Black & Decker Mfg. Co.
Delta Mfg. Co.
Walker-Turner Co.
Drilling Machines, Portable
Black & Decker Mfg. Co.
Independent Pneumatic Tool Co.
Stanley Works
Sullivan Machinery Co.
VanDorn Electric Tool Div.
Drives, Variable Speed
Reeves Pulley Co. of N. Y.
Drives, V-Belt, Rope, etc.
Allis-Chalmers Mfg. Co.
American Pulley Co.
Dayton Rubber Mfg. Co.
Ducts, Air
Carey, Philip, Co.
Ducts, Electric Feed Systems
Feedrail Corp.

Ejectors
Nash Engineering Co.
Nathan Manufacturing Co.
Electrodes, Arc Welding
Electric Arc Cutting & Welding Co.
Elevators, Electric
Barrett-Cravens Co.
Elevators, Hand Power
Barrett-Cravens Co.
Lyon Iron Works
Elevators, Hydraulic
Lyon Iron Works
Elevators, Sidewalk
Barrett-Cravens Co.
Engines, Gas
Allis-Chalmers Mfg. Co.
Sterling Engine Co.
Engines, Gasoline
Allis-Chalmers Mfg. Co.
Sterling Engine Co.
Engines, Marine, Gasoline
General Motors Sales Corp.
Sterling Engine Co.
Engines, Marine, Oil, Diesel
General Motors Sales Corp.
Sterling Engine Co.
Engines, Oil
Allis-Chalmers Mfg. Co.
Sterling Engine Co.
Engines, Oil, Diesel
Allis-Chalmers Mfg. Co.
General Motors Sales Corp.
Sterling Engine Co.
Engines, Steam, Corliss
Allis-Chalmers Mfg. Co.
Engraving Machines
Ideal Commutator Dresser Co.
Evaporators
Harris, Arthur & Co.
Exhaust Systems
American Blower Corp.
Wing, L. J., Mfg. Co.
Exhausters, Air, Gas and Vapor
Allis-Chalmers Mfg. Co.
American Blower Corp.
Nash Engineering Co.
Spencer Turbine Co.
Wing, L. J., Mfg. Co.
Extractors, Oil and Grease
Permutit Co.

Facings, Clutch
Johns-Manville
Fans, Exhaust
American Blower Corp.
Hartzell Propeller Fan Co.
Wing, L. J., Mfg. Co.
Fasteners, Belt
Dick, R. & J., Co.
Fasteners, Metal, Self-Locking
Tinnerman Products (Inc.)
Fencing, Wire, Industrial
Cyclone Fence Co.
Ferrules, Condenser Tube
Chase Brass & Copper Co.
Scovill Mfg. Co.
Files, Hand and Machine
Nicholson File Co.
Filing Machines
Continental Machines (Inc.)
Filtering Systems, Oil
Nugent, Wm. W. & Co.
Filters, Air
Fisher Governor Co.
Owens-Corning Fiberglas Corp.
Filters, Feedwater
Permutit Co.
Filters, Oil
Nugent, Wm. W. & Co.
Filters, Water
Permutit Co.
Fittings, Flow Meter Orifice
Daniel Orifice Fittings Co.
Fittings, Pipe
Chapman Valve Mfg. Co.
Crane Co.
Grinnell Co.
Parker Appliance Co.
Vogt, Henry, Machine Co.
Walworth Co.
Fittings, Pipe, Screwed and Flanged, Flexible
Barco Manufacturing Co.
Fittings, Tube, Compression, Flared or Soldered
American Brass Co.
Chase Brass & Copper Co.
Lunkenheimer Co.
Nugent, Wm. W. & Co.
Packless Metal Products Corp.
Parker Appliance Co.
Walworth Co.
Fixtures, Lighting, Electric
Benjamin Electric Mfg. Co.
Russell & Stoll Co.
Flasks, Foundry
Wood's, T. B., Sons Co.
Flexible Shaft Outfits
Walker-Turner Co.
Floats
Harris, Arthur & Co.
Wright-Austin Co.
Floor Cleaning Equipment
Kent Company
Floor Finishing Machines
Porter-Cable Machine Co.
Floor Sanding Machines
Kent Company
Floor Stands
Bond, Charles, Co.
Floor Waxing and Polishing Machines
Kent Machine Co.
Flooring, Block, Asphalt
Carey, Philip, Co.

Continued on page 28



BOILER CONTROL HEADQUARTERS

★ Here in spaces 54 and 55 you will find operating exhibits, cut-away models, and diagrams showing the latest developments in Boiler Control.

You are cordially invited to use these spaces as a headquarters for meeting your friends and for the discussion of problems in measurement and control.

Information on Combustion Control, Feed Water Control, Steam Temperature Control, Pump Control, Pressure Reducing and Desuperheating will be at your disposal.

"Boiler Control Headquarters" should be one of your "must" stops.

BAILEY METER COMPANY
1026 IVANHOE ROAD • CLEVELAND, OHIO

FIRST CALLED "impossible"
NOW CALLED
"a perfect drive"

● It is a compressor drive used by a maker of mechanical toys. "Impossible" was the forecast when TANNATE was suggested, but a trial was made despite the unfavorable conditions.

That was over six years ago and TANNATE is running still, with a gratifying performance record . . . with a grip, flexibility, capacity and endurance called "perfect"!

It is this sort of reliable service that recommends TANNATE to your attention. If you have a "problem drive," get in touch with us.

STEP UP PRODUCTION WITH
RHOADS
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WATERSHED LEATHER BELTING
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NEW YORK • CHICAGO • ATLANTA • CLEVELAND

GROUP VIII—PACIFIC NORTHWEST STUDENT MEETING, MOSCOW, IDAHO—PULLMAN, WASH., APRIL 29–30, MAY 1

With the Student Branches

A.S.M.E. Student Branches Open 1940-1941 Year With Smokers and Technical Meetings

THE 118 Student Branches of The American Society of Mechanical Engineers opened the 1940-1941 year with "get-acquainted" smokers and technical meetings at which prominent engineers or the members themselves presented engineering papers. Some Branches have planned their program for the rest of the year while others only made arrangements for the next meeting.

Besides taking part in their own Branch meetings, student members have the privilege of attending the Local Section meetings held in their vicinity and the national meetings of the Society. Many students are already making plans to attend the 1940 Annual Meeting in New York City, Dec. 2–6, at which each Branch representative will be the guest of the Old Guard at the banquet on Wednesday evening, Dec. 4. The banquet will conclude the special program planned for that day which will be known as "A.S.M.E. Student Day." Following a student meeting in the morning, the boys will join distinguished members of the Society for the annual student luncheon. In the afternoon, each student member will be able to attend one of the regular technical sessions of the Annual Meeting or go on one of the interesting inspection trips.

But, of immediate interest to student members is the news of happenings in their own and other Branches throughout the United States and Canada. For that purpose, the secretaries send in reports of meetings, inspection trips, and social affairs so that the editor may compile a running account of such happenings for these pages. The following news items were taken from reports received at A.S.M.E. headquarters up to Oct. 6, 1940.

California Welcomes President

CALIFORNIA BRANCH began functioning on Sept. 19 with a meeting attended by 67 members and 13 guests. Chairman Don Graham opened the meeting by requesting Dan Drake to lead the group in singing, after which dinner was served. Following an excellent repast, vice-chairman Hugh Gourdin introduced the guest of honor, President Warren H. McBryde of the A.S.M.E., who gave an interesting talk on "What Is Engineering?" The meeting concluded with piano selections by Bill Price.

New Officers at C.C.N.Y.

New officers of the C.C.N.Y. BRANCH were installed on Sept. 26 together with a new honorary chairman, Prof. Stephen J. Tracy. With the aid of the 42 members who were present, the officers made plans for future meetings on the subjects of the engineer in the army, problems of power generation, and power-plant engineering.

Colorado State Has Luncheon

Following the first meeting of the COLORADO STATE BRANCH on Sept. 16, at which J. T. Strate of the faculty discussed the advantages of A.S.M.E. membership, the 29 boys who were present adjourned to the mechanical-engineering laboratory where luncheon was served.

Cornell and Employment

Of the 148 members of the 1940 graduating class in the college of engineering at CORNELL UNIVERSITY, 142, or 96 per cent, are known to have definite employment, according to a statement issued on Sept. 14. Placement is 100 per cent for chemical and electrical engineers, 97.6 for mechanical engineers, 95.4 for administrative engineers in mechanical engineering, and 89.3 for civil engineers.

Two Branches Merge at Illinois Institute of Technology

On Friday, Oct. 4, 1940, the first meeting of the I.I.T. Student Branch of the A.S.M.E. was held. Resolutions were read that had been passed at the meeting of Sept. 21 as follows:

WHEREAS: there has been a merger of the

NINTH ANNUAL MEETING, A.S.M.E. GROUP IV, SOUTHERN STUDENT MEETING, BIRMINGHAM, ALA., MARCH 31, APRIL 1–2

Armour Institute of Technology and Lewis Institute, with a corporate name of Illinois Institute of Technology and

WHEREAS: each of the merging Institutes has had an active Student Branch of the A.S.M.E. with regular complement of elected officers, and

WHEREAS: the rules of the A.S.M.E. call for only one Student Branch at any engineering college,

Therefore be it resolved: that the following action be taken by a group of mechanical engineering students at Illinois Institute of Technology to provide for the 1940-1941 year pending a regularly organized Branch thereafter.

(1) That a petition be made to the A.S.M.E. for a Student Branch at the Illinois Institute of Technology.

(2) That it is herewith recommended that all funds and other property of the A.S.M.E. Student Branches of the two merged Institutes be transferred to the new A.S.M.E. Branch to be formed at the Illinois Institute of Technology.

(3) That it is recommended that the duly elected officers of each Branch of the two merged Institutes request formal dissolution of these Branches from the A.S.M.E.

(4) That for the 1940-1941 school year, there be established the regular officers of chairman, vice-chairman, secretary, and treasurer, chosen by ballot, or rising vote, from the two sets of officers of the merged Institutes, on the basis of two officers from each Institute.

(5) That the newly proposed Student Branch of the Illinois Institute of Technology vote at a regular business session for its recommendations for Honorary Chairman not later than 60 days after the National Society's approval for the Branch.

(6) That subsequent officers be chosen by regular means provided by the rules of the parent organization.

(7) That a set of these resolutions and a copy of the minutes of the meeting be sent to the parent organization for special action and approval.

The following members were recommended by the nominating committee for the vacant offices: Chairman, John Savauge; vice-chairman, Raymond Geisler; secretary, Thaddeus Wieczorek; treasurer, Edward Floreen.

A motion was made and seconded, that the slate presented by the nominating committee be accepted.

1939-1940 BUCKNELL STUDENT BRANCH

Mississippi State Smoker

MISSISSIPPI STATE BRANCH opened its season with a smoker on Oct. 2 at which the new officers and the honorary chairman, Prof. H. P. Neal, were introduced. After a brief address of welcome by chairman J. B. Buescher, the 108 who were present saw motion pictures on automotive construction and the oil fields of Europe. Prof. A. G. Holmes, Jr., head of the mechanical-engineering department, stated that any student member presenting a paper at the A.S.M.E. Student Conference next spring would be given several credits toward graduation.

Nebraska Has Joint Meeting

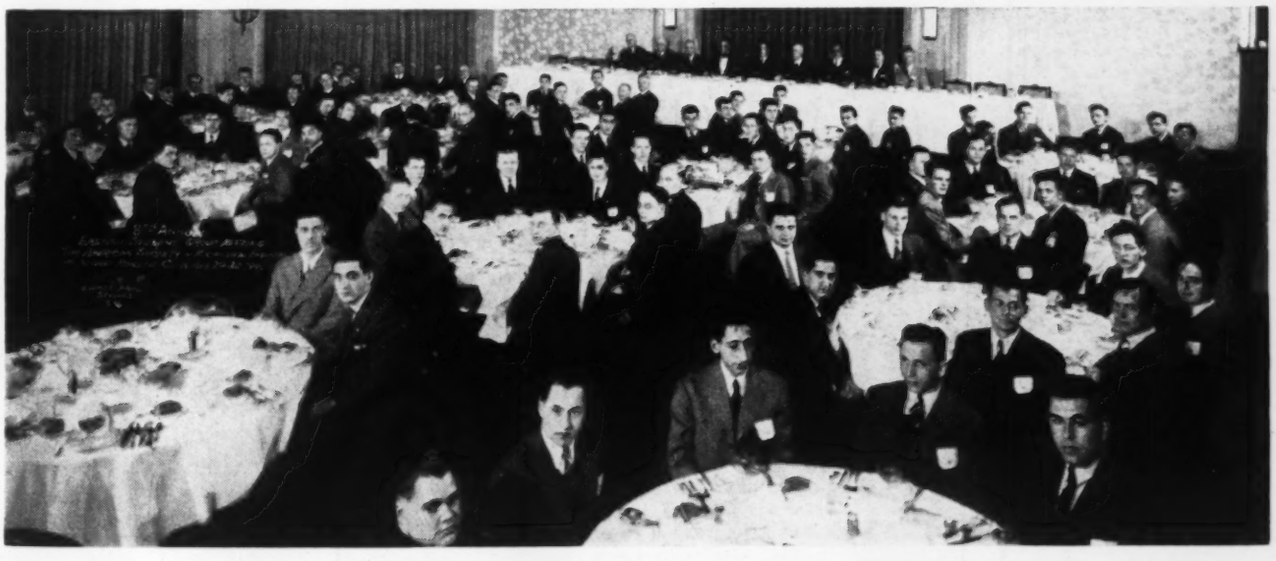
The Sept. 25 meeting of the NEBRASKA BRANCH was held jointly with the student chapter of the A.I.E.E. in preparation for a joint inspection trip on Oct. 2. The first speaker, W. R. Hazleton, Nebraska Power Co., described the Jones Street Power Station in Omaha. The second guest speaker, Don Thomas, Loup River Public Power District, discussed the interconnection between the Nebraska hydroelectric system and the various power markets in Nebraska, particularly Omaha.

Northeastern Reports 3 Meetings

Earl Finkle, corresponding secretary of the NORTHEASTERN BRANCH (division A), sent in reports of meetings held on Sept. 12, 17, and 23. The first meeting was devoted to an election of new officers. The next meeting provided an opportunity to all members to discuss the type of program they desired at future meetings. So, on Sept. 23, the members made an inspection trip to the Cambridge Ice Company plant, the largest of its kind in the Boston area.

Notre Dame Gets 26 New Members

The meeting on Sept. 19 of the NOTRE DAME BRANCH saw the introduction of the new officers and the enrollment of 26 members. Refreshments were served during the meeting.



EIGHTH ANNUAL MEETING, A.S.M.E. GROUP II, EASTERN STUDENT MEETING, NEWARK, N. J., APRIL 29–30

Oklahoma Branch Makes Plans

At the Sept. 30 meeting of the OKLAHOMA A.&M. BRANCH, plans were made to attend the Oct. 7 meeting of the Mid-Continent Section in Tulsa, and for a meeting which would be a round-table discussion of some interesting engineering topic by a group of engineers from Tulsa and Oklahoma City.

Sports at Pittsburgh

A meeting of the PITTSBURGH SECTION was called to order on Oct. 3 by Chairman H. G. Skinner. Charles Shank announced that the M.E. teams for intramural sports needed a few more candidates. Following this, those elected to Pi Tau Sigma were introduced.

Purdue Hears About Oil

The first meeting of the PURDUE BRANCH for the season was held on the evening of Sept. 19. The main event was an address by Dr. E. M. Kemler on the subject, "Engineering in the Oil Industry," in which he showed the highly important part played by the engineer in this very "speculative" business. A door prize of a free student membership was awarded to the student who drew the lucky sample copy of MECHANICAL ENGINEERING, the distinguishing mark being a hole punched through one of the inner pages. The winner was Alvin W. Meyers.

R.P.I. Students in Industry

A new plan in engineering education was put into practice at RENSSELAER POLYTECHNIC INSTITUTE this fall. Through the cooperation of the General Electric Company, a large group of carefully selected students will "go to school" for three consecutive months in the company's plants. The plan differs from other cooperative arrangements in that the graduation of the students takes place within the regular four-year period. This is accomplished mainly by including a classroom program to run concurrently with the practical experience program. Another feature of the plan is that these courses will be concentrated on three consecutive months in the junior year alone. Students undertaking the training will receive from $75 to $125 over living expenses.

Pep Talk at Rhode Island State

The first meeting of RHODE ISLAND STATE BRANCH on Oct. 2 was opened with a pep talk by Chairman Robert Afflick in which he showed the advantages of A.S.M.E. membership. Then John Chrissos explained the functions of the Army Ordnance Reserve.

100 Per Cent Attendance at Rose

The first meeting of the ROSE POLYTECHNIC BRANCH on Sept. 25 was notable for the reason that there was 100 per cent attendance of all mechanical-engineering students eligible for membership. Prof. Carl Wischmeyer, honorary chairman, outlined the reasons for A.S.M.E. membership.

U.S.C. Branch Plans Activity

At the first meeting of the UNIVERSITY OF SOUTHERN CALIFORNIA BRANCH held on Oct. 1, 37 students made application for membership. The program consisted of talks by members of the mechanical-engineering faculty on A.S.M.E. membership, the research program carried on by the Society, and the history of the Branch.

Joint Course at Stevens and Newark

A cooperative arrangement between NEWARK COLLEGE OF ENGINEERING and STEVENS INSTITUTE OF TECHNOLOGY is in operation this year whereby certain of the advanced evening courses offered by NEWARK, amounting to not more than 10 credits, may be credited toward the requirements of the degree of master of science at STEVENS.

Texas Hears About C.A.A. Plan

A period of strictly supervised training and not merely a chance to joy-ride, was how R. L. Browning, head of the local division of the C.A.A., described the civil pilot-training courses now being offered to young men and women, at the Sept. 30 meeting of the TEXAS BRANCH. Among the advantages of the program enumerated by Mr. Browning was the fact that this preliminary training not only enables the student to take advanced training but also may afford an opportunity to enter the United States Army Air Corps as a military pilot.

Villanova Starts Ball Rolling

VILLANOVA BRANCH started the school year off with a meeting on Sept. 30 at which application blanks were distributed. Besides the regular technical meetings which are held periodically, the Branch is planning a smoker for Nov. 14.

Men and Positions Available

Send inquiries to New York Office of Engineering Societies Personnel Service, Inc.

29 W. 39th St. New York, N. Y. | 211 West Wacker Drive Chicago, Ill. | 57 Post Street San Francisco, Calif. | Hotel Statler Detroit, Mich.

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 26, M.I.T. 1935. In large machine-tool plant: 15 months shop apprentice, 2 years installing bonus-incentive system. Two years equipment engineer for automatic-machine manufacturer. Location, immaterial. Me-545.

LUBRICATION ENGINEER, B.S. in M.E., M.S., 28, married. Now employed as industrial lubricants salesman by major oil company. Familiar all phases blending, marketing, and distributing petroleum products. Seeks sales-engineering position, same or affiliated industry. Will travel. Me-546.

MANUFACTURING PLANT MANAGER OR CHIEF ENGINEER, 46, single, technical graduate. Broad general mechanical- and electrical-engineering experience. Successful plant executive (diversified woodworking), organizer, systematizer, coordinator. Now employed. Me-547.

MECHANICAL ENGINEER, 39 years old, married. Experiences: 3 years shipbuilding, 11 years materials-handling equipment; 7 years with food and chemical plant as assistant to plant engineer on new equipment and new expansion. Me-548.

INSTRUCTOR IN MECHANICAL ENGINEERING. Have taught engineering drawing, hydraulics, mechanical laboratory, thermodynamics, machine design and kinematics. Two years of industrial experience. B.S. and M.S. degrees. Me-549.

ENGINEER, 44, college, registered. Twenty-eight years engineering design, construction, and production; factory engineering and operation; chemical plant and equipment design; production control and inspection methods; active charge. Mature judgment. Me-550.

MECHANICAL ENGINEERING GRADUATE, 23, 1940 graduate of leading engineering school. Courses in power-plant design, refrigeration, steam-turbine design, internal-combustion engines, theory of combustion, etc. Ambitious, neat appearance. Me-551.

MANAGEMENT EXECUTIVE, 31, B.S. Three years graduate studies; nine years' diversified experience: Factory management, production, methods, costs, design, personnel, tabulating, office, marketing analysis. Employed production manager large nationally known corporation. Me-552.

MECHANICAL ENGINEER, graduate, 25, single. Experience in design, operation, and management of plant manufacturing powdered metal; also in purchasing. Now employed, prefers position in East, preferably in machine design. Me-553.

MECHANICAL ENGINEER, 1939 graduate, B.S., 23. Realizes college training only theoretical, therefore willing to get into overalls to learn actual facts. Likes responsibility. Interested in heat-power engineering. Me-554.

CHIEF ENGINEER, technical graduate with very worth-while experience in plant layouts and engineering, equipment design and development, construction and power, maintenance and drafting-force supervision, particularly in chemical and food industries. Me-555.

MECHANICAL ENGINEER, B.S. in M.E., and M.E., 45, married. Seven years experimental, design and research in important manufacturing plants; 15 years' broad teaching experience in colleges. Member rating and licensed. Me-556.

MECHANICAL-ENGINEERING GRADUATE, 24, single. Three years' experience in rate and production work. Also three summers' experience in railroad maintenance work. Desires position in maintenance department railroad or industrial production work. Me-557.

STEEL-PLANT CHIEF ENGINEER. Wide experience in design and construction of all types of steel-plant equipment, especially in flat rolled products. Good references. Me-558.

GRADUATE MECHANICAL ENGINEER. Service engineer with boiler manufacturer, designing

[1] All men listed hold some form of A.S.M.E. membership.

and servicing boilers and related equipment. Purdue 1935 and advanced courses. Available on notice for power-plant, combustion, and allied work. Me-559.

GRADUATE MECHANICAL ENGINEER, Cornell University, 1935, M.E. Anglo-Saxon, American citizen. Time study $1\frac{1}{2}$ years. Design work, $2\frac{1}{2}$ years on small production mechanisms. Desires designing position. Me-560.

POSITIONS AVAILABLE

DESIGNERS with well-rounded experience in mechanical instrument design. Applicants must have experience with small precision parts such as gears, cams, and lever motions. Salary, $3000–$3600 year. New York metropolitan area. Y-6456.

GRADUATE ENGINEERS, 22–30, preferably with textile experience who would be interested in position in production end of cordage company. Applicants will be trained in manufacturing end of business. Excellent opportunity for advancement. East. Y-6463.

SUPERINTENDENT OR ASSISTANT SUPERINTENDENT thoroughly experienced in machine shop and punch-press work, for company manufacturing electric motors from $\frac{1}{4}$ to 15 hp. Should have ability to reduce costs and increase production. Ohio. Y-6465D.

GRADUATE ENGINEER with wide and varied experience to organize department for maintenance of perpetual inventory. Must be acquainted with securing book values and applying costs in event that these cannot be secured. Work will involve wide variation of material such as furniture, laboratory equipment, and machinery, including power plant and waterworks, as well as individual motor drives. Must be good executive and capable of directing organization. One-year contract; probably renewal. Salary, about $4500 year. Pennsylvania. Y-6476.

DIESEL ENGINE DESIGNER with experience in fundamental design, who can make stress and load calculations. Degree not essential but, if possible, company wishes man with experience in Diesel-engine work, particularly valve and control mechanism design. Salary, up to $275 a month depending upon experience. Southern Wisconsin. Y-6485-R809C.

MACHINE DESIGNER, graduate mechanical engineer, with some experience on board, designing, if possible, and detailing light and heavy machinery. Applicant will be placed under supervision squad leader with thought of advancement to this position. Should have at least 5 years' experience. Must be American citizen. South. Y-6488.

PURCHASING AGENT, with chemical background, to purchase material for company manufacturing fireworks. Plant includes powder mill, paper mill, and box plant. Prefer man with thorough knowledge of New England market. Salary, $3600–$5000 a year. New York. Y-6491.

DESIGN AND DEVELOPMENT ENGINEER, 35–50, especially qualified to design mechanical instruments. Should have had at least 8 to 10 years' experience in this field. Must be American citizen. Salary open. Ohio. Y-6499.

EXECUTIVE, 35–45, graduate in mechanical engineering from recognized engineering school. Should be top-notch mechanical engineer and have demonstrated extraordinary ability as executive and engineer. Should, at present time, hold responsible engineering or administrative position, preferably in heavy-equipment industry, and earning not less than $10,000 annually. Location, East. Y-6504.

PLANT SUPERINTENDENT, preferably 35–40, for machine shop manufacturing special light machinery item; manufacturing is largely in the nature of job work. Applicant would be expected to take complete charge and have full responsibility in operation of manufacturing departments. Must understand machining of hard alloys and wide variety of alloys in form of castings and also in sheet and tube stock. Will be required to keep adequate records on manufacturing activities, handling of all personnel problems including wage setting, etc., planning and routing of orders, assistance in setting up and operation of any machine in plant; must have ability to design at least simple tools. Good appearance and personality. Salary, $55–$60 a week. Excellent opportunity. New York State. Y-6530.

ENGINEER, 30–35, interested in position in negotiation department of large company manufacturing electric machinery. No outside sales work involved but applicant should have previous sales contacts. Duties will include working up of estimates, preparatory to quoting, on inquiries particularly on export work. Knowledge of export situation desirable but not essential. New York, N. Y. Y-6533.

DESIGNER, 30–40, who has special qualifications and experience in design of equipment for high-pressure synthesis operations. Should have thorough knowledge of stress analysis, plasticity, and metallography of steel. It is desirable that applicant be experienced in design of heavy machinery, such as hyper compressors and converters and be acquainted with shop practice with some experience in direction of designers and draftsmen. Salary open. Location, East. Y-6536.

GRADUATE MECHANICAL OR METALLURGICAL ENGINEER, young, to learn wire-and-cable business and eventually work into sales department of organization. Should have some sales experience or at least desire to enter sales work. Some metallurgical experience desired. Salary, $25 week. Location, New England. Y-6544.

SUPERINTENDENT, not over 34, for power plant consisting of total installed turbine capacity of about 7500 kw; the boiler capacity consists of eight 300-hp Edgemoor boilers. Will also be required to supervise maintenance and changes in power equipment and distribution system to mills, employee housing, etc., and assist in overhauling and modernizing of plant. Must have had practical and theoretical experience and be, preferably, single. Location, foreign. Y-6560.

MAINTENANCE FOREMAN, preferably college graduate, who has had 3 to 10 years' experience in plant-maintenance supervision. New York State. Y-6562.

MATERIAL RECORDS ENGINEER experienced in engineering practice and terms, combined with some knowledge of purchasing material and scheduling and planning work. Must be American citizen. State salary expected. Transportation furnished. South. Y-6578.

DRAFTSMAN, 35–50, with considerable experience in drafting room, in power-plant work of all kinds, including piping layouts, foundations, structural design; some experience on electrical layouts desirable but not essential. Applicant must be tactful and have ability to command respect of others. Excellent opportunity for advancement. Salary, $350 a month. Ohio. Y-6581D.

GRADUATE MECHANICAL ENGINEER, over 25, with experience in scheduling and planning work and a leaning toward industrial-engineering field. Will be required to help set up and operate production department. Pennsylvania. Y-6582.

GRADUATE MECHANICAL ENGINEERS, young, with 2 to 5 years' experience in time study and industrial engineering in general. Salary, $150–$200 a month. New England. Y-6598.

Civil Service Positions

Applications may be secured from U. S. Civil Service Commission, Washington, D. C., or any First-Class Post Office

AIRCRAFT PROCUREMENT INSPECTOR, assistant to senior grades, $2000 to $2600 a year. Optional subjects include aircraft, engines, instruments, parachutes, aircraft propellers, and tools and gages. Positions are open at Wright Field, Dayton, Ohio. There is no written test. Applications will be accepted until further notice.

INSTRUCTOR, Air Corps Technical School, junior to full grades, $2000 to $3800 a year. Requirements include graduation from high school and completion of 4 years of experience as instructor in shop subjects or as a shop supervisor, although engineering experience may be accepted. Maximum age is 53 years. Applications will be accepted until further notice.

ENGINEER, assistant to senior grades, $2600 to $4600 a year. Requirements include completion of a four-year course leading to a bachelor degree in engineering in a college or university of recognized standing. Maximum age is 55 years. Closing date is June 30, 1941.

INSPECTOR, junior to senior grades, $1620 to $2600 a year. There are three tests under this title, one for engineering materials (aeronautical); the second for ship construction (hulls, mechanical, electrical); and the third for engineering materials (hulls, mechanical, electrical, and radio). Applicants must have had inspectional experience. Maximum age for junior grade is 35 years, and for other grades is 55 years. Applications will be accepted until further notice.

Civil Service positions for mechanical engineer, marine engineer, engineer (junior grade), engineering aid (aeronautical), engineering draftsman, and aeronautical engineer, which are still open, were listed on page 772 of MECHANICAL ENGINEERING for October, 1940.